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The Institute of Vitreous Enamellers
The National Ironfounding Employers' Federation
The Welsh Engineers' and Founders' Association
and
The Foundry Trades' Equipment and Supplies Association

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Telephone: 332

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The British Industries Fair

The character of the Birmingham Section of the British Industries Fair is gradually changing year by year; one sees the disappearance of one after another of the heavy engineering firms as exhibitors. It is highly probable that annually is too frequent a period for this class of exhibit. Moreover, the cost of an exhibit varies directly with the weight of the machinery installed. On the other hand, the exhibition is becoming increasingly important for the manufacturers of hardware and light castings, especially fitted goods. The month of February has been selected as being the best for the buyers of this class of merchandise, and all hopes of reverting to May have, unfortunately, vanished. This adverb "unfortunately" is used to refer only to the climatic conditions normally experienced during the late winter months. For the foundry executive, there remain but few exhibits for him to examine coming within the category of foundry plant. Even the local manufacturers of cupolas and moulding machines have dropped out. For foundry supplies, the exhibition maintains its authoritative character, and eight firms show ranges of their pig-irons. There are exhibits of foundry sundries and supplies, such as core oil, fluxes, parting powder and Bentonite; whilst the last remnant of foundry plant shown is that of core stoves. The hollow-ware and light-castings foundries are extremely well represented, and it takes several pages of the catalogue to list them. We think that on these grounds it is well worth while making the journey to Castle Bromwich, and foundry executives would be well advised to inspect the stands of the suppliers of their raw materials, then the few stands showing plant, including such items as weighing machines and testing apparatus, and then devote the remainder of the time at their disposal to inspecting the highly-commendable finishes which are shown on the stands of the various foundry owners. This advice might seem somewhat trite, but when it is realised that there are about 11½ miles of stands, a proper planning of one's programme is essential if a maximum benefit is to be derived from time spent at the Fair. It is with this object that we have reviewed very briefly the exhibits likely to be of interest to our readers.

Shortage of Managers—I

The principal of a technical college recently declared publicly that the demand for skilled foundry workers was increasing daily and that employers were finding it difficult to obtain skilled men. He recommended parents to consider the foundry as a career for their sons, as conditions and wages had improved, and cited the case of a foundry proprietor who had expressed his willingness to pay £1,000 a year to a suitably-qualified manager, but was unable to find the man he wanted.

This statement gives rise to so many reflections that it cannot be dealt with in the space of one article. It is certainly true that conditions and wages have improved, and a number of foresighted men have encouraged their sons to make the foundry a career. But it takes time to produce a manager, and the demand has arisen so speedily that it has temporarily exceeded the available supply. We are far from hoping that so many outsiders will enter the industry as to create a fresh problem when the cycle brings round retrenchment rather than expansion. It seems better in every way for the industry to make the best use of the men it already has, and we are a long way from accepting the statement that men cannot be obtained for a four-figure salary. It is in fact quite easy to prepare a specification for a man that could not be satisfied at a five-figure salary for the very simple reason that such men are not to be obtained. It is no use, for example, looking for a man who has a university degree, with the experience and polish that enables him to interview company directors and clients, along with lengthy personal practical experience in various branches of the industry, experienced in handling labour and administrative problems, and in large-scale purchasing and selling. A few points, however, may be considered.

In recent discussion a prominent educationist said that all business men in interviewing candidates for jobs were out for that elusive thing called personality, a thing which could not be taught, and which a man either had or had not. A man might develop what he has, but essentially it is that little something the others havn't got which carries conviction and persuades whenever a personal contact is made. He went on to express the view that often personality, in what is often only a short interview, is confused with personal appearance and bearing, which is only part of the story. We shall suggest later that managers to-day need more than experience, and that every foundry has to bear a small share of responsibility for training the type of man they may one day have to employ.

Correspondence

[We accept no responsibility for the statements made or the opinions expressed by our correspondents]

The Preliminary Costing Report

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—The members of the Costing Sub-Committee are pleased to note the interest taken in their recent Paper on "Melting and Moulding Costs," and would like to reply to the letter published in your issue of February 6.

"Ad Valorem" quotes the following statement:—"Value is not the point to be considered, but rather the cost": the present writer, having himself made a similar statement on a previous occasion, acknowledges that this sentence can be misconstrued. In relation to home scrap we do not like the term "value" taken alone, because it is indefinite. Scrap has a metallurgical value, a market value and a cost value. As regards home scrap, what we are concerned with is its *cost value.*

We have been given the task of recommending a method whereby the cost of making castings may be ascertained. Many factors govern the cost of making a casting. We have endeavoured to analyse these factors and to consider each one at its *true cost.* Home scrap is one of the factors that influence the final result, and, therefore, home scrap, like any other factor, must be taken at its true cost.

The difference of opinion about home scrap lies in its metal cost. It cannot be denied that the cost value of the home scrap as metal is the cost value of the mixture of metal (pig-iron, and bought scrap, if any) from which it originates. If, therefore, we take market value, or any other figure than cost of metal mixture, we do not account for home scrap at its true cost, and the results of the cost sheet or of the estimates are falsified. *The difference between true cost and market price must be found somewhere.*

The example given by "Ad Valorem" does not disprove our findings, because it does not follow our method. If "Ad Valorem" will refer to the text of our Paper (FOUNDRY TRADE JOURNAL, December 26, 1935, page 467, column 2), he will see that we recommend that "the cost of home scrap in a given mixture charged into the cupola be the average (mean) cost of the pig-iron and bought scrap that go into the charge, in the proportion in which they are charged." A little lower we state: "In allowing for returned scrap from that melt, the same figure will be used."

In his example, "Ad Valorem" uses market price in the charge, but under (A) he uses "mixture cost" when crediting the home scrap back to stock. We use "mixture cost" in both places. Furthermore, it is necessary to include bought scrap in a general example, because if a foundry used pig-iron and home scrap only, we would figure home scrap at the same price as the pig-iron. If our suggestions are followed, the example is as follows:—

		£	s.	d.
Mixture	5 tons pig-iron at £4 per ton	20	0	0
	2 tons bought scrap at £2 10s.	5	0	0
	3 tons home scrap at £3 11s. 6d.	10	14	6
10		£35	14	6

We assume that we charge 2 tons of bought scrap and 3 tons of home scrap, and the "mixture cost" of home scrap in this example is £25 for 7 tons, or £3 11s. 6d. per ton approx. (A) in "Ad Valorem's" example becomes:—

	£	s.	d.
Scrap to stock 3 tons at £3 11s. 6d.	10	14	6
Cost of casting 6½ tons	25	0	0

Cost of casting per ton = £3 17s. approx.

In the case of (B) the metal mixture would be costed with home scrap at market price:—

	£	s.	d.
5 tons pig at £4 per ton	20	0	0
2 tons bought scrap at £2 10s. ...	5	0	0
3 tons home scrap at £2 10s. ...	7	10	0
10	£32	10	0

and the result would be:—

	£	s.	d.
Scrap to stock 3 tons at £2 10s. ...	7	10	0
Cost of casting 6½ tons	25	0	0

Cost of casting per ton = £3 17s. approx.

The result is the same in the two cases: why?—because in this example we charge exactly as much home scrap as we credit back from the melt. In other words, where home scrap is charged in exactly the same quantity as is returned to stock, it does not matter what price is put to home scrap, provided, of course, that the same price is used in calculating the charge and in crediting back to stock.

In current practice, however, the ratio of home scrap charged to home scrap returned does not remain constantly at 1. There are bound to be some fluctuations, and the price at which home scrap is priced in the charge and credited back has an influence on the final result. Therefore, the *true cost value* of home scrap must be used. By varying the proportions in the example it will be seen that in some cases the cost per ton of the casting will be somewhat higher with home scrap at "mixture cost" than with home scrap at market price. In other cases it will be somewhat lower. The differences will not be so great as in "Ad Valorem's" example.

"Ad Valorem's" friend cannot say "my costs are lower (or higher) by one method than by the other," because there is only one true cost, which is given by taking the true cost of all factors, including home scrap. As regards his statement that "the price of (home) scrap will be continually increasing until it *almost* reaches the value of the pig-iron," we would state that in most well-conducted foundries where home scrap is used up and not allowed to accumulate, and the composition of charges does not vary considerably for a given class of castings, the cost value of home scrap based on "mixture cost" will fluctuate, within rather narrow limits, around an average figure, and will not continually increase.

As regards the price to be allowed for home scrap in estimates, our answer is that we apply the same principle of "mixture cost." When the composition of the charge is calculated, provision is made for a certain quantity of bought scrap and home scrap to be charged in certain proportions. The price per ton of the home scrap will be the same as the price per ton of the mixture of pig-iron and bought scrap taken together. Obviously, in an estimate the figures are not accurate to the same extent as in a cost sheet for a period of actual operation, and, therefore, there must be a certain amount of approximation, not only as regards home scrap, but also as regards many other factors.

Finally, with regard to the financial accounts prepared by accountants, we have already stated that we are only concerned with finding the actual cost of making castings. If the accountants or the management decide to depreciate stocks of raw materials at the end of the financial year, this depreciation is accounted for in the costing system through overheads. As regards the "stock value" of home scrap, this will admittedly be higher if based on "mixture cost" than if based on "market price," but as long as the foundry is operating, we see no reason why the stock of home scrap should be written down to market price. Furthermore, in well-conducted foundries where home scrap is not allowed to accumulate, the value of the stock of home scrap would be quite small in relation to other stocks and other assets. Of course, when an undertaking is to be liquidated, the stock of home scrap should then be written down to market value.—Yours, etc.,

V. DELPORT,
Convenor of the Costing Sub-Committee.

Caxton House,
Westminster, S.W.1.
February 17, 1936.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—I have been very pleased to note the progress made by the Institute of British Foundrymen's Sub-Committee on Costing, and sincerely hope that their work will be heartily supported by all connected with the foundry work. This subject of accurate costing is, I feel, one of paramount importance to any progressive industry, and I have already expressed my views in letters to leading technical journals and national newspapers.

Briefly, these are that considerable harm is being done to industry by firms who have not reliable knowledge of their costs, and by quoting uneconomic prices are depressing the market generally, besides securing their own downfall.

It is, therefore, to be hoped that some uniform system of costing for the founding industry will be universally adopted in the interests of a more prosperous and healthier state of affairs.—Yours, etc.,

DAVID BROWN,
Managing Director.

David Brown & Sons (Hudd.), Limited,
Huddersfield.
February 17, 1936.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—Regarding the above report, which was read by the Vice-President of the Middlesbrough Branch, Mr. Mercer, on February 7, I regret that at the time I did not raise any remarks regarding it. Having since been through this article again, I should like to draw your attention to one remark which I consider needs rectification.

I refer to the last few lines of the right-hand paragraph, page 468, of the December 26, 1935, issue of THE FOUNDRY TRADE JOURNAL, which stated: "Applying this to a job made from mixture A, yielding from 50 to 60 per cent. of good castings," etc.

Although it is appreciated that all the figures in this Paper simply show hypothetical cases, I consider that the statement of "50 to 60 per cent. of good castings" is rather misleading, considering that the figures with regard to the cost of pig-iron and scrap are such that one might pay at various times. Whereas a foundry only obtaining between 50 to 60 per cent. good castings of metal melted would appear to require some considerable adjustment in the moulding department.

In the light-castings trade such a figure would certainly have to be between 70 and 80 per cent. in order to give satisfaction to the company concerned.—Yours, etc.,

D. R. KINNELL.

Chas. P. Kinnell & Company, Limited,
Vulcan Iron Works, Thornaby-on-Tees.
February 14, 1936.

The Whifflet Foundry of R. B. Tennent, Limited

MANUFACTURE OF "ADAMITE" ROLLS

The foundries of R. B. Tennent, Limited, situated at Coatbridge, are exceptionally conveniently placed in regard to the Scottish and North of England steelworks, and as branch lines from the L.M.S. and L.N.E. Railways go direct into the works, they have excellent facilities for transport. The works had their inception in 1857, when the late Mr. R. B. Tennent commenced business as a general ironfounder, but it was not until the early 80's that he commenced the manufacture of rolls. Prior to that time practically all the heavy rolls for steelworks were made in Staffordshire and Wales.

The late Mr. R. B. Tennent became interested in a patented process for casting chilled rolls; briefly, this consisted in inserting a metal cone into the mould and bottom-pouring round it. The greatest secrecy was observed, and the casting was done behind locked doors; the result, however, was disastrous, the roll breaking into a number of pieces. The inventor returned home, and Mr. Tennent devoted himself to the manufacture of rolls on more orthodox lines. He was the first roll-maker in Scotland seriously to challenge the Staffordshire industry.

A distinctly enterprising man, with a real appreciation of the value of attention to detail, he speedily established a successful business as a roll-maker, and in 1900 the business was converted into a limited company under its present style. Mr. James Tennent, a grandson of the founder, is presently managing director, and is also chairman of the Roll Makers' Association.

It is worth recording that a new foundry, which was nearing completion in 1900, was practically demolished by the gale which swept the country in December of that year. Under the present management, the whole works have been practically reconstructed, and a steel plant has been put down with a furnace capacity of 50 tons. The present output of the works covers the complete range of roll requirements, including cast-iron grain rolls, cast-iron chilled rolls, steel rolls of all qualities, and Pilger rolls for tube mills.

FIG. 1.—GENERAL VIEW IN ROLL FOUNDRY OF MESSRS. R. B. TENNENT, LIMITED.

Melting Plant

The melting plant comprises four reverberatory furnaces of melting capacities ranging from 25 to 35 tons, sidings and stocking ground extending along the range of the furnaces. The furnaces are coal fired. The question of firing with pulverised fuel was carefully considered, but was negatived as an unsound commercial proposition with Scottish coals. Two 3-ton cupolas are installed, and are blown by Roots blowers, and the charging platform is served by an electric crane. There is also a 50-ton open-hearth furnace already referred to, built in 1903. Scrap and other materials are delivered to the charging platform by an overhead crane. The furnace has a removable roof, which enables heavy scrap, sometimes in sizes up to 15 tons, to be charged direct on to the hearth.

The foundry occupies a building 450 ft. by 60 ft. On an upper gantry there are two 50-ton electric cranes, whilst the lower runways carry two cranes, each of 25 tons capacity. There is nothing in the nature of the equipment which calls for special mention. The floor is amply furnished with casting pits, which range up to 35 ft. in depth from floor level. In all there are 13 coke-fired drying stoves. The average daily output of the foundry is 100 tons of iron and 40 tons of steel castings. The sand plant of the runner-mill type calls for no special mention. It is of interest to note that Messrs. Tennent were the manufacturers of the cogging and plate mills of Messrs. Dorman, Long & Company, Limited, at Redcar Works.

With regard to actual productions, it may be mentioned that an iron roll, weighing 47 tons 6 cwts. when finished, has been cast, whilst a chilled roll has been cast weighing 35½ tons when finished. With the modern developments in mill design and construction, there has naturally grown up a demand for a better roll, a roll of a better finish and of a quality the extra cost of which would be justified by its greater working life.

The management of the Whifflet foundry early recognised the commercial possibilities of a higher grade of roll, but they were not prepared to commit themselves to any particular process until they had thoroughly investigated the progress in roll manufacture at home, on the Continent and abroad, and as the outcome of exhaustive investigation they entered into an arrangement with the Macintosh-Hemphill Company, of the United States, for the manufacture of "Adamite" rolls in this country.

"Adamite" rolls were manufactured in the United States so far back as 1913. Early troubles were, of course, experienced, just as faulty applications were made, and it would perhaps be true to say that the real development of the "Adamite" process of roll manufacture dates from 1922, when the business of the pioneer manufacturers, the Pittsburgh Foundry Company, was taken over by the Macintosh-Hemphill Company.

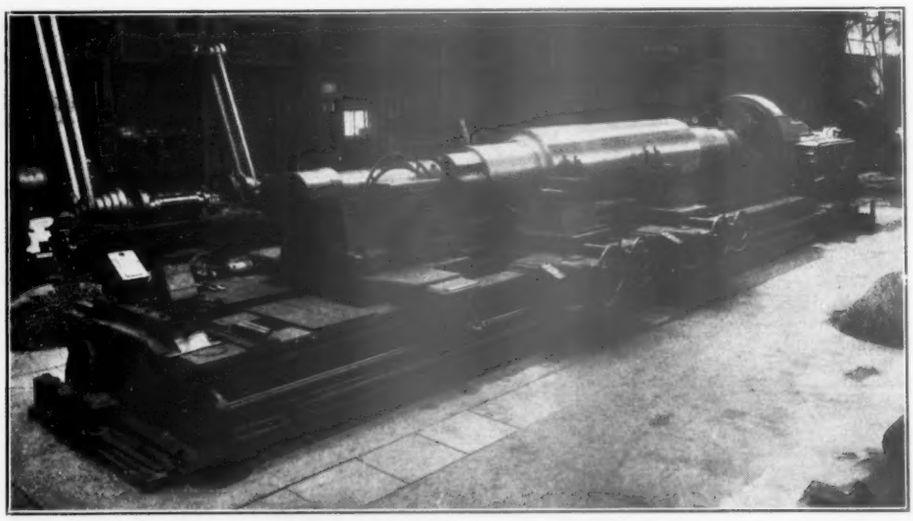

FIG. 2.—MACHINING CHILLED PLATE ROLL 12 FT. 7 IN. BY 43 IN. DIA. FINISHED WEIGHT, 35¼ TONS (SEE FIG. 4).

Broadly speaking, the "Adamite" alloy is made in two forms, *i.e.*, as a steel base and as a cast-iron base alloy. The former is made in five different grades and the latter as chilled or grain castings, the duty of the rolls, of course, determining the particular grade from which they are made.

The steel-base "Adamite" rolls have the whole of the carbon content in the combined form, with a scleroscope hardness number ranging from 32 to 55, this hardness being substantially constant throughout the mass; the degree of hardness is, of course, governed by the required duty, and for special services may be as high as 55. In all cases (steel or cast-iron base) the alloys have the same low phosphorus content, and have chromium and nickel as the main alloying elements. They differ in regard to silicon and carbon content, and, in the steel-base varieties, as regards their melting and subsequent heat-treatment.

There is a decidedly important difference structurally between the "Adamite" iron-base alloy chilled roll and the ordinary chilled cast-iron roll. In the first-named there is no noticeable line of demarcation between the hard outer surface and the body of the metal, from which it is evident that the diminution of hardness is very gradual, thus adding to the wear-resisting qualities of the roll. It is claimed that the "Adamite" chilled roll, despite its hard internal structure, is at least 30 per cent. stronger than ordinary cast-iron chilled rolls.

The manufacture of "Adamite," of course, called for certain structural alterations to the existing plant, and the introduction of some new auxiliaries, amongst the most important being the re-equipment of the annealing shop. The steel compositions are, of course, produced in the open-hearth furnace and the iron-base alloys in the reverberatory furnaces.

Annealing Shop

The annealing shop is served by two 3-ton overhead cranes. The furnace equipment at present comprises a Howden oil-fired and a Howden coal-fired furnace. Two similar furnaces are, however, in course of erection.

The furnace chambers are identical in size, 23 ft. by 13 ft. 6 in. by 6 ft. high to the spring of the crown; they are of the bogie type, the bogies being moved by a pinion and rack through a Walwork worm-reduction gear from a ½-h.p. motor. The bogies are designed to carry a load of 100 tons, *i.e.*, the full capacity of the furnace. The doors of the furnaces have cast-iron frames filled with Stein special insulation and are back-balanced and hand-operated.

The coal-fired furnace is fired from four boxes, set staggered, two on either side, with the down-take flue arranged between them. The fire bridges are sufficiently high to throw the flame over the rolls under treatment. A charge is in the furnace for 72 hrs., the fuel consumption being 4 cwts. per hr.

The oil-fired furnace has two preheating chambers on each side. These chambers are normally used for preheating a charge of rolls, and when the critical temperature is passed, they are shut off and the furnace is direct fired from four burners on each side. Air for combustion is supplied by a Howden fan driven by a 5-h.p. motor, which delivers the air at 14-in. w.g. through a main air pipe into the regenerator pipes along the top of the furnace, the final temperature being approximately 300 deg. Fah. The preheating chambers are under thermostatic control by Foster instruments, whilst there is a similar thermostatic control to each four burners. The control is within 5 per cent. plus or minus.

Oil fuel is pumped from the tank wagons into the storage tank by an electrically-driven pump, and through a changeover valve the same pump discharges from the storage tank to the auxiliary tank at the furnace, the pump coming automatically into operation according to the level of the oil in the auxiliary tank.

The operation of this furnace is, of course, much more costly than that of the coal-fired furnace, but it is laid off more particularly for the "Adamite" rolls, the heat-treatment of which plays a most important part in the successful production. Perfect control over the heating of the rolls, the maintenance of the temperature for a determined period, and the rate of subsequent cooling are vital factors which can be maintained indefinitely in the furnace under notice, but which would be wholly impossible in the coal-fired furnace.

The roll-turning shop is served by two 50-ton overhead cranes, the equipment including 15 roll lathes, the most recent additions installed, particularly for service with "Adamite" rolls, being two lathes of 36 in. and 30 in. respectively, built to the company's requirements by Craven Bros. (Manchester), Limited, and a Churchill roll-grinding machine, 24 ft. between centres, which will thus take the largest roll made.

FIG. 3.—CASTING FIRST "ADAMITE" ROLL. FINISHED WEIGHT, 20 TONS.

Production of Steel Castings

CONSIDERATION OF PRINCIPAL FACTORS

At a meeting of the Staffordshire Iron and Steel Institute (Associates' Section), held on February 7, MR. G. T. HAMPTON read a Paper on "The Production of Medium-Sized Steel Castings," in the course of which he pointed out that the fundamental difference between the production of iron castings and steel castings is twofold, namely, steel has a much lower proportion of metalloids, therefore a higher melting point and consequently decreased fluidity range; also in cooling, there is greater contraction from the liquid state and volume changes are undergone when passing through the critical range. Consequently all modifications of ironfoundry practice rendered necessary in the manufacture of steel castings are entirely due to the widely-differing physical properties of the metals. Of the many factors governing the production of steel castings the most important is co-operation between designer, patternmaker, moulder and metallurgist, together with departmental supervision.

Shrinkage and Dimensions

In order to obtain a casting of specified dimensions, allowance must be made for the shrinkage of cast steel as it cools from the solidification point. Free solid contraction from freezing point to room temperature is approximately 6.6 per cent., the linear contraction being about 2.2 per cent. The linear shrinkage of steel as it cools from the liquid state involves an actual movement of the casting through the sand. In the case of a perfectly flat piece with no projections, such as flanges, bosses or brackets, normal unimpeded contraction takes place. The presence of such details reduces the measurable contraction because such details prevent unrestricted movement. The presence of feeding heads, too, prevents this movement. Where unimpeded contraction cannot take place there is another factor influencing the allowances to be made, that is, the variations in compression strength of the different moulding and core sands that may be used, these variations being wide in the different classes of steel-moulding compositions.

Apart from the shrinkage which takes place when cooling after solidification, there is a physical change taking place when the steel solidifies. Experiments by Dr. Benedicks and calculations made by Honda show that steel passing from the liquid to solid phase contracts about 5.5 per cent. of its volume. T. M. Service explains the amount of contraction in steel in the following manner—solid steel weighs 490 lbs. per cubic foot, but liquid steel weighs only 437 lbs. per cubic foot, equal to a change in specific gravity of from 7.85 to 7.00. Therefore to obtain one cubic foot of solid steel 1.12 cubic feet of fluid steel will be required, or a total shrinkage of 10.72 per cent. takes place from 1,500 deg. C., to room temperature. As solidification commences around the outside of the mass and the shell of freezing metal gradually thickens, it is inevitable that the last liquid metal will fail to fill completely the hollow enclosed by the steadily thickening walls and a cavity results equal to approximately 5.5 per cent. of the liquid volume. The simplest form of steel casting is the tapered ingot, cast wide-end up and it illustrates the ideal, that is controlled directional solidification. Thus, as far as possible, a steel casting should be made with the heavier sections above the light ones. This ensures that the upper portions will tend to freeze last, and so feed the contraction of the lighter sections below. By using a superimposed feeding head, solidification is controlled giving a casting which is free from defect, the cavity being localised in the surplus metal. This condition is similar to the hot-top ingot, in which the cavity is confined to the feeding head by making full use of controlled solidification. This idea of controlled solidification is the first consideration in the production of steel ingots, but as regards steel castings the designer produces the ultimate shapes most likely best to suit his purpose. He then looks to the foundryman to make the best job of it, irrespective of the complexities of the design. Heads must be sufficiently numerous to feed all points where there is a tendency for the thinner sections to draw from the thicker parts, and generally each section will demand separate feeding. The form and size of heads must be such that the cavity which forms in them does not extend into the casting itself. It will be apparent that it may be necessary to use feeding heads in excess of the weight of actual casting.

Application of Chills

Where it is not practicable to feed isolated heavy sections from risers, chills are applied. The function of these is not, as in iron castings, to produce a change in the structure of the metal next to them by which it is made harder, but simply to cool rapidly the metal that lies in contact with them. The object of this is twofold—it causes part of the casting to cool and solidify rapidly, often while pouring is still in progress, so that in that part of the casting contraction occurs and the shrinkage cavity is formed, while other parts of the casting are still molten. Thus, feeding of the chilled part occurs early and the cavity is fed from a thinner section which remains liquid longer than the chilled section. Thus controlled solidification is obtained. Then chilling evens up the rate of cooling of a casting with light and heavy sec-

(*Concluded on page* 160.)

FIG. 4.—CHILLED PLATE ROLL 43 IN. DIA. BY 12 FT. 7 IN. LONG ON BARREL. FINISHED WEIGHT, 35¼ TONS (SEE FIG. 2).

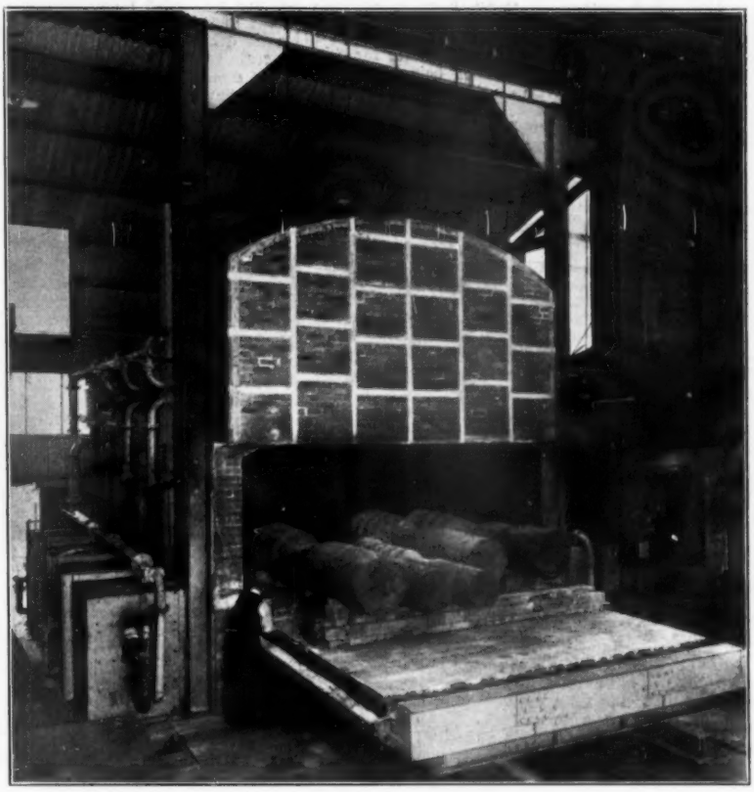

FIG. 5.—OIL-FIRED ANNEALING STOVE FOR "ADAMITE" ROLLS. CAPACITY, 100 TONS.

ROLL FOUNDRY OF R. B. TENNENT, LIMITED.

British Industries Fair

EXHIBITS AT CASTLE BROMWICH SECTION

The hardware section of the British Industries Fair was opened at Castle Bromwich, Birmingham, last Monday, and will remain open until February 28. The exhibits are arranged in the following groups: (A) Hardware, ironmongery and brassfoundry; (B) building; (C) gas and electricity; (D) engineering.

We append very brief notes relating to the principal exhibits likely to be of interest to our readers.

Edgar Allen & Company, Limited, Sheffield.—Exhibits include the Imperial vibrating scrubber and washer; the Imperial vibrating screen; the Stag K-B rotary granulator and the Tiger plate frame crusher; also a selection of drill steels for mining purposes and a display of Stag Major superweld tools, Stag twist drills and small tools, and Edgar Allen die steels. The Edgar Allen Imperial vibrating screen works on the principle of a patented eccentric motion of unique design, incorporating two main duplex bearings, each fitted with two roller races in the same housing, the inner races being arranged eccentrically and transmitting a throw to the body of the machine, thus giving a positive vibrating motion to the screens. A further exhibit is the Edgar Allen Imperial patented scrubber and washer, creating a new departure in the design and type of machine generally used for scrubbing and washing such materials as gravel, dirty stone, sand, coal, etc.

Atlas Preservative Company, Limited, Erith.—A display consisting of mechanical models designed to demonstrate the elasticity and durability of "Atlas Ruskilla" iron and steel paint, together with coated specimens, test-plates, etc. "Ruskilla" is elastic, and consequently does not chip nor crack, but expands and contracts with the metal. It is made in black, white, aluminium, and a range of attractive colours, all of which have good covering power and pleasing finish.

W. & T. Avery, Limited, Birmingham.—Perhaps the most interesting exhibit is an industrial visible weigher with weigh-record indicator. This machine, in addition to giving visible indications of exact weight up to high capacities, also prints an accurate record of every load passing over the machine, either on a ticket or a continuous tape, or on both a ticket and a tape. Another interesting machine is the tinplate grading machine, which receives tinplates and automatically grades them according to weight into three groups—correct, light or heavy. This machine deals with 20 sheets per minute.

B.E.N. Patents, Limited, London.—A representative selection of B.E.N. air compressors and spray-painting machines and equipment, from a small outfit that can be carried by hand to larger multi-gun spray sets, portable and fixed, for industrial purposes. The spraying-equipment exhibits include various types of spray guns for gravity, suction and pressure feed, together with all fittings necessary for high-grade spray-finishing work.

British Oxygen Company, Limited, London.—A section of the stand is devoted to Ferro-Arc electrodes. Demonstrations of electrodes comprising a wide range are being given, a Mawdsley tandem single-operator arc-welding set being used for the purpose. An English Electric single-operator transformer oil-cooled unit with a combined regulator is also shown. The oxy-acetylene welding and cutting exhibits are grouped to show the reclamation of worn parts by the oxy-acetylene process and the advantage of oxy-acetylene welding in railway engineering. Other equipment includes oxy-acetylene hand equipment for cutting steels and iron and for the welding and heating of metals, etc. A section of the stand shows the spraying of metals with the metal-spraying pistol.

The British Rema Manufacturing Company, Limited, Halifax.—A comprehensive exhibit of machines from the wide range of crushing, pulverising, classifying and mixing plant. The machines include the British Rema ball mill and vacuum classifying plant; ring roll mill, fitted with the patented vacuum system of classification and drying; heavy-duty exhauster fan; British Rema multiplex pulverised-fuel-firing unit. This machine has been developed for replacing oil and hand firing for small furnaces and boilers consuming from 50 lbs. to 600 lbs. of coal per hr. Other exhibits include a high-efficiency air separator; paddle-type mixer and disintegrators; wet mixer and emulsifier; British Rema swing-hammer crusher, of the type supplied for crushing coal, limestone, etc., which is provided with easily-adjusted hammers and breaker blocks, and renewable manganese-liner plates and grids; British Rema pneumatic dryer, in which small wet material containing 20 per cent. of water can be thoroughly and uniformly dried down to 2 per cent. of moisture without heating up the material to more than 150 deg. Fah.

Consett Iron Company, Limited, Consett, County Durham.—Exhibits of hematite, pig-iron, foundry coke, and silica and firebricks, all in high-quality grades.

The Earl of Dudley's Round Oak Works, Limited, Brierley Hill, Staffs.—A wide range of rolled-steel sections and bars manufactured for railway rolling stock, constructional engineering drop stamping, bright drawing, nut and bolt making, and for all general engineering and many special purposes. These sections and bars are in various qualities of steel, including "Edrow" rust-resisting steel and also "Edrowlite" high-tensile rust-resisting steel; also genuine cold-blast pig-iron, which is used in the manufacture of chilled rolls, cylinders and other special castings.

Thos. Firth & John Brown, Limited, Sheffield.—A complete range of engineers' small tools, including high-speed twist drills, milling cutters and reamers, circular metal-cutting saws, band saws and slitting saws, circular metal-cutting "Insto" saws with inserted teeth, the well-known "Millenicut" file, and lathe tools, both solid and butt welded. Prominence is given to high-speed steels and alloy steels, castings and forgings for all purposes, etc.

Firth-Vickers Stainless Steels, Limited, Sheffield.—A comprehensive range of Firth-Vickers stainless and "Staybrite" steels, the stand being sectionalised so as to give prominence to its particular applications; other sections illustrate examples of "Staybrite" for the chemical, brewery, dairy and textile industries.

General Refractories, Limited, Sheffield.—Exhibit includes specimens of most of their products, a special display being made of refractories designed for the gas industry, made by the Meltham Silica Brick Company, Limited, which is now associated with General Refractories, Limited; examples of the extraordinary good finish to Meltham silica bricks is demonstrated in sections of gas retorts and settings, coke ovens, etc. Firebricks of all types are also exhibited, including specimen sleeves, nozzles and stoppers, together with cupola linings and boiler-furnace lining materials: also "Supermag," "Diazite" and the new "Saxpyre" brick and other basic refractories for open-hearth steel furnaces, electric steel furnaces, copper furnaces, etc.

Gibbons (Dudley), Limited, Dudley.—A full range of high-class refractory materials for all purposes. In addition to bricks and special shapes in fireclay and high alumina materials, furnace engineers in particular will be interested in the range of super refractories of carborundum, fused alumina and sillimanite, and also in the Gibbons H.T.1 refractory insulating brick.

Gibbons Brothers, Limited, Dudley.—Exhibit includes a rotary gas-fired enamel melting furnace for experimental batches of enamel frit; also a continuous annealing or heat-treatment furnace fitted with a novel type of conveyor mechanism, known as the "Baldwins-Marchant" furnace conveyor gear. Originally designed for conveying steel bars for sheet and tinplate manufacture, through a reheating furnace. Messrs. Gibbons Bros. have now developed this furnace for conveying steel trays carrying pressings, stampings, etc., through a heat-treatment furnace.

Quest Products, Limited, Wharton Winsford, Cheshire.—An exhibit covering core compound, parting powders, dextrines, plumbagoes, steel-moulders' paint, furnace linings and Bentonite.

The Rapid Magnetting Machine Company, Limited, Birmingham.—Exhibit of representative selection of various types of electro-magnetic separators, scrap-sorting magnets, lifting magnets, magnetic chucks and clutches, etc. Most of the exhibits will be in actual operation, including "Circular" pattern electro-lifting magnets, controlled by the manufacturers' patent potentiometer controller, handling pig-iron, steel roll and heavy castings of iron, etc.

Renishaw Iron Company, Limited, Renishaw, near Sheffield.—Show foundry pig-irons, Derbyshire quality, for both general engineering and light castings. Amongst these are special low-phosphorus and high-manganese irons for high-duty application.

George Salter & Company, Limited, West Bromwich.—An exhibit covering a wide range of manufactures, including springs for every purpose and of every material; roller bearings in a wide range of sizes (bearings can be supplied with flexible or solid rollers, with solid inner and outer races, and with solid rollers and split sleeves); testing machines for cement, sand cores, wire, rope thread, paper, etc.; safe-load indicators for jib cranes; spring balances and weighing machines for warehouses, docks, collieries, etc.; iron castings; pressure and vacuum gauges, etc.

The Staveley Coal & Iron Company, Limited, Chesterfield.—Various grades of coal for industrial, household and gasmaking purposes; samples of various grades of pig-irons produced; also a series of fractures of the different grades; sand-spun pipes, 4 in. to 24 in. dia., 16-ft. lengths supplied with socket-and-spigot joints; turned and bored joints; Staveley flexible joints; cast-iron pipes of 1½ in. dia. and upwards in 9-ft. and 12-ft. lengths; sample cast-iron pipe bitumen-coated on the outside—pipes thus coated are intended for laying in aggressive soils; Staveley flexible joints, both bolted type and clamp type; Staveley tarred slag for road-making and road-surfacing; Stabita, a scientifically-blended mixture of high-grade coke-oven refined tar with bitumen, for road-spraying; wood wool; chemical and by-products, etc.

John G. Stein & Company, Limited, Bonnybridge, Stirlingshire.—All types of refractories, including Sillimanite for melting metal for the foundry industry. A feature is being made of high-alumina bricks containing 63 and 73 per cent. alumina. Special attention is also given to refractory cements.

Stewarts and Lloyds, Limited, Glasgow, Birmingham and London.—Although not covering the complete range of their manufacture, this exhibit includes tubes ranging from ⅛-in. to 54-in. bore, embracing screwed and socketed, gas, water and steam tubes, black and galvanised, steel pipes for gas, water and sewage mains and distribution systems, oil pipes and casing, high-pressure steam pipes, boiler tubes, etc. The variety of joints available, comprising spigot and socket, welded and fixed or loose-flange types, "Victaulic" joints and Johnson couplings, cover every requirement. In addition there are shown foundry and forge pig-irons, steel strip and sections, and steel castings. The well-established "Security" pit props, and Tollcross and Jones-Davies props are of interest and particularly the recently-introduced controlled-yield supports, the efficiency of which has been still more increased by the adoption of a new type of head to unite the camber girder and the tubular legs.

The United Steel Companies, Limited, Sheffield.—A composite exhibit, in which STEEL, PEECH & TOZER show railway and tramway wheels and axles, a locomotive crankshaft, and a range of tyres, discs and solid wheels. A bored axle, showing the cleanness of the bore is also displayed; WORKINGTON IRON & STEEL COMPANY, rails and steel sleepers; DANIEL DONCASTER & SONS, LIMITED, a finished connecting rod with a connecting-rod forging, together with draw-bar hooks, piston rods and slide bars; also a display of valves. SAMUEL FOX & COMPANY, LIMITED, show a range of the commercial vehicle springs, also gears made in various alloy steels; cold-rolled steel strip in various qualities, together with some examples of their range of the different qualities of wire; also specimens of special alloy steels. UNITED STRIP & BAR MILLS are showing hot-rolled steel strip in various finishes; another product displayed by this branch is barrel hoops with a galvanised finish. Included in this exhibit is a display of "Stribar" reinforcing bars. APPLEBY-FRODINGHAM STEEL COMPANY, LIMITED, have a display showing uses for their well-known plates. THOS. BUTLIN & COMPANY, show a range of castings for civil engineering.

Wild-Barfield Electric Furnaces, Limited, London.—Electric furnaces of various types, ranging from the "heavy-hairpin" box-type furnace down to the smallest muffle, and including forced-air circulation furnaces, practically all the furnaces on the stand being in continuous operation.

The Manufacture and Utilisation of Electric Steel in the Foundry*

By T. R. WALKER, B.A., and C. J. DADSWELL

Historical

Although the production of large quantities of steel by electric melting is of comparatively recent growth, Siemens, as far back as 1878, took out a patent for an electric-arc furnace which, in its essentials, is very similar to the furnaces operated at the present time. The fact that this Siemens furnace was not used commercially was due, primarily, to the prohibitive cost of generating electricity at that time and for many years afterwards. It was not until the early years of the twentieth century that electricity became cheap enough to be used on a large scale industrially. About that time many types of electric melting furnaces were designed, utilising different principles, and the first electric steel manufactured in this country was made at the Vickers Sheffield Works in 1907. The furnace employed was a Kjellin furnace, which operated by utilising the heating effect of low-frequency currents applied to the charge. This furnace had a brief and undistinguished career, as it was uneconomical in operation and had the great disadvantage that part of the charge had to be left in the furnace to conduct the electricity for the following charge, so that it was impracticable to make successive charges of substantially different chemical analysis.

In 1910 the first Héroult furnace in this country was put down at Edgar Allen's works in Sheffield, and this was followed a year later by one at the Vickers Works. These furnaces were of the three-electrode type, using electric arcs, and arc furnaces of this and similar designs have been very popular both in this country and elsewhere ever since.

In the early days of electric melting it was commonly thought that good electric steel could be made from any type of raw material, whether this was good or bad. The same opinion was held shortly after the introduction of the basic open-hearth process, but in each case it has been found subsequently by experience that the manufacture of good steel by the basic process demands good raw material and care at each stage during its manufacture.

Steel for Castings

From a foundry point of view, steel which is to be regarded as good should lie quietly in the moulds without any evolution of gas, it should be fluid over a wide range of temperature, and it should not attack the mould materials. To some extent these requirements are incompatible. If the mould material is not to be attacked, the steel should be poured at as low a temperature as possible. This practice is likely to introduce difficulties in the way of short runs, cold shuts, cold laps and other defects, and also to lead to the occurrence of skull in a ladle after casting. Castings made from electric steel are, in general, small compared with those made from open-hearth steel, and this often involves a considerable number of openings and closings of the ladle nozzle. It is quite common, for example, for the nozzle of a 3-ton ladle to be opened and closed between 50 and 100 times during the pouring of a heat, and the steel must be hot enough and sufficiently fluid to allow this to be carried out. Where large numbers of small castings are made in this way, it is clear that if the steel is of the correct temperature at first, it will be cold by the time the last castings are poured, and if it is correct at the end of the pouring it will be too hot for the first castings run. This may lead to enlarged shrinkage cavities where the steel is too hot and cold laps or short runs where the steel is too cold, so that a compromise must be adopted to suit the various circumstances as well as possible.

The fluidity, " castability " or running life of electric steel is not entirely governed by the temperature. In some cases the steel may be extremely hot, but at the same time sluggish and difficult to run. It is then said to be " dazed," over-killed or too dead. This condition of the steel is extremely difficult to correct in any reasonable time when once it has been allowed to develop its occurrence, and must, therefore, be prevented by attention to detail throughout the operation of making the steel.

Basic Electric Steel

Steel manufactured in electric furnaces may be made in furnaces with either an acid or a basic lining, the difference being that in the case of acid-lined furnaces no reduction of sulphur and phosphorus is possible, whilst with basic-lined furnaces a considerable reduction in these elements, particularly in the case of phosphorus, may be carried out. Electric furnaces with acid linings are coming into prominence in the United States, but acid electric melting has not hitherto been carried out to any great extent in this country. From a steelmaking point of view, therefore, it appears best to confine the Paper to basic electric steel. On this subject alone books have been written, very many different methods being available for the production of such steel, and in the time available it is proposed to refer to only one particular method of making basic electric steel, a method which has been found to give very good results. It is particularly suited to the production of carbon steel for castings, containing, say, 0.15 to 0.4 per cent. of carbon, which embraces the composition of the majority of castings made in English foundries, and it gives very good results when used for the manufacture of green-sand castings, which are ordinarily more difficult to make sound than castings made in dried moulds.

A brief outline of the steps taken in the manufacture of a heat of steel of the kind referred to is as follows. The charge is first melted, precautions being taken to prevent the oxidation of the iron which would yield oxides very difficult to remove subsequently. Next, any dissolved gases other than carbon monoxide, such as nitrogen and hydrogen, are removed by means of a current of carbon monoxide. The carbon monoxide remaining in the bath is then removed, the steel deoxidised and raised to the tapping temperature. Final additions are made and the steel tested on the furnace stage before being tapped and sent into the foundry.

Contrasts with Open Hearth

In open-hearth practice the charge usually consists of a mixture of pig-iron and scrap, but in electric-furnace practice the charge frequently consists entirely of scrap, made up partly of runners, risers and waster castings, and generally containing a substantial proportion of steel turnings, frequently more or less oxidised. The melting of this charge is accompanied by the oxidation of the elements in it, this process being facilitated if the initial small bath of molten material is allowed to rise to a very high temperature. The bulk of the charge consists of iron, and during melting the other elements present, notably carbon and manganese, are oxidised before the iron, but if the content of these elements is allowed to fall to a very low figure the iron of the bath begins to oxidise, producing oxides of iron which are extremely difficult to remove, and give rise to very undesirable effects in the steel. Where turnings are allowed to accumulate in considerable quantities they should be stored under cover so as to reduce the surface oxidation, since any oxides in the charge will readily react with both carbon and manganese on heating.

Since the charge consists entirely of steel, it will naturally melt with a much lower carbon content than is usual in the open-hearth furnace, where a good deal of the charge consists of pig-iron. In order to provide enough carbon and manganese to protect the iron from oxidation, and also to provide a sufficiently high-carbon content for a boil, which will be referred to later, it is advisable to include in the charge powdered anthracite, ground electrode or ground coke, these consisting essentially of carbon, and also to include some manganese-steel scrap, or some ferro-manganese if manganese steel is not available. Most of the steel used in a foundry contains 0.2 to 3 per cent. carbon and for the manufacture of this sufficient materials containing carbon and manganese should be added to the charge to give a melting carbon of 0.4 to 0.5 per cent., with a manganese content of round about 0.2 per cent. Melting down should be carried out moderately hard, but not so quickly as to develop small lakes of highly-heated metal below the electrodes.

When the charge is melted a sample is taken for analysis and will give the carbon and manganese at this stage. The first slag is now made in the usual manner and dissolved gases, such as nitrogen and hydrogen, are expelled from the bath by a current of carbon monoxide. This carbon monoxide is produced by additions of ore, the oxygen in which reacts with the carbon of the bath, giving bubbles of carbon monoxide which are evolved as a gas.

A New Viewpoint

It is necessary to eliminate dissolved gases as far as possible so as to avoid an evolution of gases when the steel is poured into the moulds. If the steel during casting contained a good deal of dissolved gases it would be unsuitable, particularly for green-sand work, since steam is evolved from the surface of green-sand moulds and a current of steam passing through the liquid steel would disturb the equilibrium of the dissolved gases, causing them to be evolved. In addition, any sharp excrescences in the mould would favour the evolution of dissolved gases in exactly the same way as a piece of material with sharp points will prevent the bumping or intermittent boiling of water in a flask.

The boil produced in the steel should be as vigorous as possible and the ore added should, therefore, be in lumps of, say, first size and not in powder form. A short brisk boil is far more valuable in driving out dissolved gases than a long slow boil, even although the reduction in carbon content, and consequently the amount of carbon monoxide evolved, is the same in each case. The amount of ore to be added per ton of charge naturally depends on the melting carbon and should be sufficient to reduce the carbon to such a figure below the final carbon content desired as will allow the difference to be made up by the addition of recarburising and deoxidising alloys. In any case, the carbon content of the bath must be reduced to such a figure as will enable dephosphorisation to take place, since a substantial content of carbon protects phosphorus from oxidation. If the scrap used for the charge consist entirely of waste material from the same foundry dephosphorisation is not important since the scrap will all be of the low-phosphorus type. Usually, however, the charge includes turnings derived from

* A Paper read before the Sheffield Branch of the Institute of British Foundrymen, Mr. A. Whiteley presiding. The authors are respectively Chief Research Chemist, English Steel Corporation, Limited, and Foundry Manager, English Steel Corporation, Limited.

material other than that melted in the electric furnace, and in such cases dephosphorisation is advisable.

Slagging Off

When the charge is entirely melted the bath is raised to a moderately high temperature. It must be made hot enough to ensure a complete separation of metal and slag, and also to allow the power to be cut off in a few minutes during the slagging operation without the bath beginning to freeze. For slagging off, the furnace is tilted slightly and the slag removed through the back door. It is important that this slag should be completely removed, since any small islands of slag remaining would allow rephosphorisation to take place, and would also take up a good deal of time in getting the second slag into condition.

At this stage the bath is saturated with carbon monoxide and contains other oxides, so that a sample of the metal will rise in the spoon and be full of holes. It is, therefore, necessary for reduction processes to be carried out. If a sample taken for analysis now shows that the carbon content is too low, some carbon is added to the bath in the form of powdered anthracite, powdered electrode or some other form of carbon with low ash content. At this point it

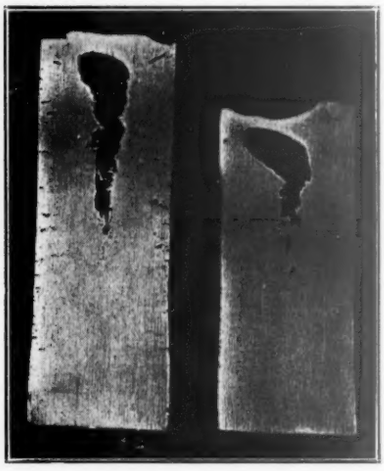

FIG. 1.—TEST INGOTS FOR ASCERTAINING SOUNDNESS.

is quite easy to deoxidise the bath, or in other words reduce any dissolved oxides present, by a sudden heavy dose of ferro-silicon. This eliminates other oxides but leaves as its product of the deoxidising process silica, the oxide of silicon, forming insoluble non-metallic inclusions in the steel which are very difficult to remove, and interfere seriously with the fluidity of the steel as cast. It is much better to carry out the deoxidation as far as possible with manganese, since this gives as a product of the process manganese oxide which can easily be decomposed and reformed, and is also easily moved from the bath into the slag and *vice versa*. The process is as follows: The manganese reduces oxides in the steel such as carbon monoxide and ferrous oxide, being itself converted to manganese oxide which then moves upwards into the slag. In the slag the manganese oxide is reduced by silicon to metallic manganese which returns to the metal bath. Here it reduces more oxides and is converted to manganese oxide which moves into the slag and is reduced to metallic manganese and so on. The production is thus carried out substantially by manganese in the metal and by silicon in the slag.

Deoxidation and Desulphurisation

After slagging off, therefore, about two-thirds of the ferro-manganese required in the ordinary way for finishing, is added to the bath in lump form, the exact amount depending on the manganese content of the bath at this stage. Slag-making materials in the form of lime and fluorspar are added, together with some anthracite coal dust, this latter serving partly to hold the carbon content of the bath and partly to assist as an additional element in the reducing process. The slag quickly turns brown or black owing to the presence of manganese, and further additions of lime and fluorspar are made at intervals, as required, to keep the slag in condition. Small amounts of powdered coal are also added at intervals for the same purposes as before. Gradually, the slag begins to turn lighter in colour and steel-spoon samples show that the bath is becoming less wild. At the beginning of the deoxidising stage the steel is much below the temperature required for tapping. The steel should be heated only gradually during this stage. It should not be quickly raised to a very high temperature and kept there, since if the steel is very hot throughout the reducing stage, it is extremely difficult to maintain a proper control over the slag and metal conditions.

During the reducing process, as the temperature is rising gradually, it is often found that when a certain temperature is reached successive samples of the metal do not become less wild, in other words, the process of reduction is suspended. This is because the deoxidising power of manganese diminishes as the temperature rises until it is unable to reduce carbon monoxide. In this case it is impracticable to carry out complete deoxidation by manganese alone, and a stronger reducing agent must be used at the higher temperatures. This agent is silicon, and it is, therefore, necessary to add small amounts of powdered ferro-silicon to complete the deoxidation of the bath. This powdered ferro-silicon should be added at intervals and no more than is necessary for complete deoxidation should be used on account of its bad effect on the running life of the steel. At this stage it will be found that the slag lightens in colour very rapidly and finally turns white. Shortly after this it falls to a powder on being exposed to the air for a short time and the powder smells of acetylene. This falling white slag represents the final stage in the process of reduction, and it is important that the metal should not be maintained under this slag for longer than is necessary.

Composition Adjustment

An amount of lump ferro-silicon, representing that necessary to give the silicon content required in the finished steel, is now added, and ferro-manganese, also sufficient to give the carbon and manganese contents required, is put into the bath, this amount being judged from the analysis of a spoon sample taken a few minutes before the addition. Throughout this latter period the temperature of the steel has been gradually rising and at this stage it should be just right for tapping. Its temperature is judged by taking a spoon sample and noting the time which elapses before the surface of the sample solidifies. The steel will be in good condition and the sample will solidify quietly without any evolution of gas. It is advisable now to verify the fact that the steel contains only a small amount of dissolved gases, especially if the metal is to be used for green-sand castings. It is, therefore, tested by pouring a sample into a small green-sand mould on the stage. The steel should lie quietly in this and solidify without any evolution of gas.

Stewing

It sometimes happens, unfortunately, that there is some delay at this stage owing to the ladle not being ready, or cranes being busy, or to the fact that the foundry workers have not completed the closing of the moulds. It is important to realise that when steel is brought into condition and to a tapping temperature it is ready to come out of the furnace, in exactly the same way as a cake which is properly cooked. Any long period during which the steel is held at the tapping temperature under a falling white slag gives bad effects. If it is known in time that there is going to be a considerable waiting period, it is much better to delay bringing the steel into tapping condition, and not to obtain a white slag by the addition of ferro-silicon.

When the steel is sent to the foundry floor, it is good practice to cast two small rectangular castings, say, 2 in. sq. by 7 or 8 in. long, one in green sand and the other in a chill mould. These may be subsequently sectioned and afford valuable evidence regarding the soundness of the solidified steel. This is sometimes very useful when complaints are received that some castings in a particular heat show gas cavities. These, of course, may be due to the condition of the steel, but they are frequently caused by errors in the manufacture of the moulds.

A Control Method

Fig. 1 shows the sections of two of these small test samples cast from two separate heats of the same composition—in this case carbon steel, containing 0.35 per cent. of carbon. The sample "A" shows that the steel solidified soundly apart from the natural contraction cavity at the top of the sample. Sample "B," however, shows a number of gas holes, located chiefly under the surface of the sample. From these results it might be expected that castings from the heat represented by "A" would be satisfactory, whilst those from the same cast as "B" would be likely to show gas cavities.

FIG. 2.—CAST WHEEL EXHIBITING BLOW-HOLES DUE TO METHOD OF RUNNING.

Fig. 2 shows part of the rim of a cast wheel, the edge of the rim having been machined by the removal of a thin skin. A good many holes are visible which may, without further evidence, be due either to faulty steel or bad foundry practice. In this particular case the casting was run from the centre. In the same cast one or two other exactly similar castings were run from the rim by means of a tangential runner. In this latter case the number of pinholes was very much less than in the casting shown, so that the existence of these holes, in this case at any rate, is largely attributable to the method of casting adopted in the foundry.

Typical Charge Sheet

The following is a typical history of a 3-ton electric steel cast for mild carbon-steel castings made by the process outlined above.

	C. Per cent.	Si. Per cent.	Mn. Per cent.	S. Per cent.	P. Per cent.
Specified analysis	0.20–0.33	0.4 max.	0.8–1.1	0.04 max.	0.04 max.
Actual analysis	0.215	0.226	0.94	0.024	0.021

	Lbs.
Charge—Carbon steel turnings	5,264
Foundry carbon steel scrap	2,464
Foundry manganese steel scrap	336
Total metal charged	8,064

24 lbs. crushed coal, 70 lbs. lime } also charged.

Time.

2.35 Power on. Current approximately 6,000 amps. at 90 volts.
4.45 Clear melted. Sample analysed gave carbon 0.30 per cent. Voltage reduced to 60.
5.07 35 lbs. ore added in small quantities at a time.
5.17 Sample analysed gave carbon 0.12 per cent.
5.23 336 lbs. Manganese steel scrap added.
5.35–5.39 First slag removed
5.40 14 lbs. lump ferro-manganese added, followed by 110 lbs. lime, 20 lbs. fluorspar and 3 lbs. coal dust for slag making.
5.45 Slag brown/black. Metal spoon sample wild.
5.50 3 lbs. coal dust added.
5.55 4 lbs. fluorspar added.
5.58 Spoon sample analysed—gave carbon 0.18; Mn 0.60 per cent.—metal still wild.
6.01 6 lbs. coal dust and 8 lbs. powdered ferro-silicon added.
6.02 Slag lightening in colour—metal sample less wild.
6.05 30 lbs. lime; 8 lbs. powdered ferro-silicon and 6 lbs. coal dust added.
6.06 Slag dirty grey.
6.13 6 lbs. powdered ferro-silicon and 4 lbs. coal dust added.
6.20 Slag white. Metal spoon sample slightly wild—metal cool.
6.20 4 lbs. lime; 4 lbs. coal dust; 4 lbs. powdered ferro-silicon added.
6.21 28 lbs. lump ferro-silicon added for finishing.
6.27 27 lbs. lump ferro-manganese added for finishing. Slag white and falling.
6.35 Metal sample quiet and almost hot enough.
6.38 Furnace ready for tapping.
6.39 Furnace tapped.

High Temperature and Poor Life

Earlier in the Paper reference was made to the fact that it is quite possible for steel melted in an electric furnace to be extremely hot and at the same time to be sluggish in running, the steel in this condition being said to be dazed or over-killed. Such steel is also referred to sometimes as being over-reduced. These latter two terms have the same significance, both referring to the removal of oxides and oxygen from the steel. The solubility of liquid steel for gases and oxides increases with rise of temperature, and if at a high temperature the steel is saturated with gases, these gases will come out as solution and be evolved on cooling, and also subsequently during freezing. The solubility of oxygen and of iron oxide in steel is only small, but if the steel is nearly saturated with oxide, this will react with the carbon present in the steel as the temperature falls, producing carbon monoxide as a gas. It might be considered, therefore, that the ideal condition of liquid steel would be one in which there were no oxides of metal present and no carbon monoxide dissolved. This is, however, by no means the case.

If steel be held under a reducing slag for a considerable length of time, oxides of various kinds are progressively reduced, and the total oxygen content of the steel falls to a low figure. This is the condition in which the steel, although extremely hot, may at the same time be viscous and difficult to pour into moulds so as to fill them completely. It seems, therefore, that it is necessary to have a small amount of oxides present in the steel, but these should be limited in amount and be present in such forms as do not interfere with the fluidity of the steel. Actually, a small content of oxygen and oxides increases the running life of liquid steel considerably, and this is, therefore, the condition to be sought in the production of steel for castings. This condition in which a small amount of oxygen is left in the steel, the amount being neither small enough to cause the steel to be sluggish nor large enough to permit of gas evolution during casting, is not always easy to arrive at with certainty. As a general rule, it is better to aim at having the steel somewhat too little reduced than over-reduced, so that there will be some slight tendency to the formation of gas cavities. This tendency is easily removed by the addition to the metal in the ladle of metallic aluminium; such an addition should be made with care, and it should never be necessary to add more than 6 ozs. of aluminium to the ton of steel. This addition will have a small effect in reducing the castability or running life of the steel, but this is much preferable to having a condition in which the steel is over-reduced.

The Resultant Steel

From a foundry point of view, although the basic electric furnace can produce excellent steel, it can also yield steel with very poor properties. With ordinary furnace practice, however, there should be no difficulty in obtaining the mechanical tests called for in the usual specifications for steel castings. As has already been remarked, one of the most important requirements from electric steel for foundries is that it should have a long running life, since it is usually poured through the bottom of a ladle, the nozzle of which must be opened and closed a great many times during the filling of the moulds. As this property of running life or "castability" is so important in foundry steels it is quite time that steps were taken by the technical bodies concerned to standardise the use of some one word to describe it, since its value, whilst important, depends on many different factors, such as viscosity, temperature and chemical composition.

Life Tests

Comparing basic electric steel with that made by other methods, in castability basic electric steel is probably not so good as Tropenas steel and acid electric steel; these latter two are very similar in this respect, though acid electric steel has the slight advantage that its temperature can be more easily controlled than that of Tropenas steel. Acid open-hearth steel is scarcely so suitable for foundry purposes as basic electric steel, again owing to the fact that the temperature of the basic electric steel can be more readily controlled, and in particular because, when required, the electric steel can be made very hot without losing its good qualities. Nowadays, acid open-hearth furnaces are not often used as small units for making steel castings. For example, a common size for basic electric furnaces is 3 tons capacity, whilst open-hearth furnaces seldom have a capacity less than 10 to 15 tons. In the case of the open-hearth charge there is, therefore, at the beginning of the pouring a very much greater head of steel in the ladle, and this naturally has important effects when the first moulds are being filled.

Reference must be made here to the manufacture of basic open-hearth steel for foundries. This has not hitherto been employed to any extent in this country, but is regularly used in America for making green-sand castings, some of which are about 5 cwts. in weight with a minimum thickness of half an inch, but it is in any case difficult to compare British and American foundry practice, since the requirements both of the foundry and of the inspectors are so different in the two cases.

Green-Sand Castings

The manufacture of light steel castings in green sand is a somewhat specialised branch of foundry practice which is of increasing importance in this country, and there are various points which merit consideration when it is desired to make steel castings which from their nature appear to be on the border-line as regards possibility of manufacture in green sand. Some of these points are as follow:—(1) Adequacy in size and correctness of distribution of the runners, and (2) the provision of a sufficient number of whistlers and heads to enable the air in the mould and any evolved gases to escape.

These points may appear elementary, but they frequently receive insufficient attention when a new type of casting is to be made in a steel foundry specialising in green-sand work. There is often, for example, a tendency to multiply the number of feeder heads quite unnecessarily in making some types of complicated light castings now manufactured in large quantities in green sand. Beyond serving the purpose of adding to the fluid pressure of the steel in the mould during pouring and for a few seconds afterwards, and also as a means of collecting mould dirt and slag, these heads have very little effect subsequently in feeding the liquid steel whilst it is contracting, the reason being that many of the more complicated castings have thick sections joined to thin sections through which ordinary feeding is impossible. Apart from the weight of material involved in the use of an excessive number of feeder heads, there is a substantial increase in cost involved in removing them and in dressing the casting.

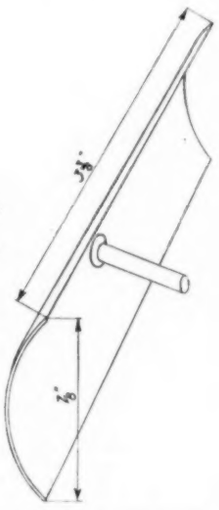

FIG. 3.—FORM OF STEEL-SHEET CHILL FOR FILLETED POSITIONS.

The soundness of these thick sections can be ensured with greater certainty by the use of internal and external chills. In this connection the following modification of moulding practice is frequently of appreciable value. When quantities of green-sand moulds are being made on a jolting machine, and it is desired to introduce an extra chill into the mould, to place the chill on the pattern and to jolt it up with the sand usually gives unsatisfactory results, since the chill may be placed wrongly, and even if put in the correct position will probably be jolted out of place. In this case it is much better to put a print on the pattern and to introduce the chill into the mould during closing in exactly the same way as one introduces cores.

Sheet-Steel Chills

Another method of chilling which is particularly useful for light sections where it is desired to carry out extra chilling in such places as fillets, is to have sheet steel, about $\frac{1}{8}$ in. thick, bent to the form of the mould and attached to the sand during closing by means of a sprig or spike welded to the sheet. A simple form of this type of chill is illustrated in Fig. 3. These chills can be manufactured very cheaply by pressing, and the cost of the press tools is small if a large quantity of similar chills are to be

made for mass-production work. Such chills can be applied very easily to a green-sand mould during closing and have the additional advantage that they do not drop from the castings, removing in this way one source of danger to the conveyors where mechanical knock-out systems are in use. Again, the chills are so cheap that there is no need to collect them for repeated use as in the case of cast-iron chills, and if they are in an inaccessible position, for example in cores, they may be left in the casting without any ill-effects. Chills of this type are used in several foundries in America, but have so far not been utilised to any extent in British foundries.

Medium Carbon Steel

Reverting to the use of basic electric steel in foundries, the most troublesome steel, as far as the occurrence of gas holes is concerned, is a carbon steel containing about 0.35 to 0.4 per cent. carbon. With this composition it is at times extremely difficult to avoid the formation of gas holes, especially in green-sand moulds, these very often taking the form of small pin-holes. It is sometimes found with this type of steel that castings made in dry sand are free from this trouble, whilst those in the same cast made in green-sand moulds contain a good many pinholes, so that for some reason, which has not yet been satisfactorily explained, steel of this carbon is very prone to evolve gases. Trouble with carbon steel of this composition is not, however, confined to that made by the basic electric process, as when made by other methods it has sometimes proved unreliable in its properties.

The formation of pinholes, referred to above, is by no means to be ascribed to the use of green-sand moulds containing an excessive quantity of water, as it occurs even when the green sand contains less than 3 per cent. of water. One suggestion for the explanation of the formation of gas holes, especially in green-sand moulds, has been put forward by Mr. Lemoine, who maintains that if the turnings used in the furnace charge are wet, the moisture present, on being heated to the temperature of the electric furnace, dissociates into oxygen and hydrogen, the hydrogen dissolving in the liquid steel. He suggests that if this hydrogen is not completely removed whilst the steel is in the furnace, the intense local heating of the surface of the green-sand mould produces dissociation of the steam evolved from the mould, thus giving a further amount of hydrogen which the steel is unable to dissolve, the additional amount being evolved as a gas. If, however, the charge is given an adequate boil as recommended earlier in this Paper any hydrogen dissolved in the bath will be removed, rendering pin-hole formation less likely.

An American Theory

A theory very different from the above has recently been advanced in America to explain the formation of subcutaneous blowholes, claiming that they are due to non-metallic inclusions. It is suggested that when liquid steel fills a green-sand mould gases are generated which try to escape through both the mould material and the liquid steel. At first it is easier for them to escape through the mould material, since the steel skin formed quickly on the surface of the mould is supported by the ferrostatic pressure of the liquid steel inside. As the mould becomes heated the gas pressure increases. The envelope of steel solidifies at a much higher temperature than the inclusions, and it is suggested that at some time during this period a small amount of mould gas is able to enter the casting by way of the still liquid inclusions.

Cracks in Castings

Turning now to the occurrence of cracks in foundry steel, basic electric steel, at least in the case of the lower carbon steels, such as magnet steel and castings containing 0.2 to 0.3 per cent. carbon, gives much less trouble in this respect than steel of the same composition made either by the Tropenas or by the acid open-hearth process. The steel foundry with which the writers are connected is served by both basic electric and acid open-hearth steel, and the superiority of the electric steel in this respect has been very definitely observed. In order to suggest an explanation of the reason why electric steel is superior in this way it will be useful to recapitulate briefly the practices commonly adopted for controlling the occurrence of contraction cracks. These are as follow:—

(1) The composition and preparation of the steel in the furnace; (2) the selection of a suitable pouring temperature and a satisfactory pouring rate; (3) the careful preparation of moulds and cores to avoid undue stresses in the castings; (4) the use of chills and brackets; (5) the correct placing of runners; (6) the easing of the moulds and cores immediately after casting; (7) casting into moulds which have previously been warmed, and (8) careful consideration of the design of castings.

On many occasions when castings from the same pattern have been made in basic electric and in acid open-hearth steel, the only differences which could have influenced a tendency to crack have been covered by the first two factors enumerated above, all the others being eliminated since they are common to both processes. As a rule the temperature of the electric steel is somewhat higher than that of the open-hearth steel, so that to this extent the electric steel would be at a disadvantage compared with the open-hearth steel. The difference in chemical composition between the two charges is largely a matter of sulphur and phosphorus content, this being lower in the case of the electric steel, but as in general the sulphur and phosphorus in the open-hearth steel would not exceed in each case 0.04 per cent., it does not appear that a difference in chemical composition can account for the difference in behaviour of the two steels.

The electric steel is poured through the bottom of a 3-ton ladle, whilst the open hearth is cast in a similar way from a 15-ton ladle, and it might be thought that this difference was significant. Actually, however, experiments have been carried out in which the ladle stream from the 15-ton ladle has been interrupted, for example, by means of a tundish, without any improvement being secured in the results from a cracking point of view. It seems probable, therefore, that the preparation of the electric steel in the way described above, gives it in some way a distinct advantage over the acid open-hearth steel as far as cracking is concerned.

Cost Reduction

It will be interesting at this point to consider the possibilities of reducing the cost of liquid electric steel supplied to the foundry. Where the scrap used for making up the charge is entirely derived from a foundry in which basic electric steel is exclusively used, the sulphur and phosphorus contents of the scrap are much below the specified maximum, and it seems in these cases a wasteful procedure to occupy time in dephosphorising. It would certainly be possible to tap the steel when the first slag had been removed, and the bath merely brought into condition for adding the finishings. In some cases the steel thus produced would be quite satisfactory for its intended purpose, but it must be emphasised that to save time it would be necessary to abandon the vigorous boil recommended earlier in the Paper, so that the steel produced would not be particularly suitable for the manufacture of light green-sand castings.

With the basic electric process, the modern furnaces have an appreciably higher melting rate than the older ones, but there is a limit beyond which the melting rate should not be pushed, and other considerations limit the voltages and electrode sizes which it is possible to use, so that when every consideration is favourable, there is a minimum cost of melting by the basic electric process which cannot safely be further reduced. These facts, together with the difficulties experienced in obtaining good magnesite during the late war, led many steel-foundries in America to investigate the possibilities of developing the acid electric process. A year or two ago there were over 250 acid electric furnaces in operation in the United States, and at present on the Continent they are becoming increasingly popular. The acid electric furnace is very suitable for the rapid production of small castings, especially in green sand, since, when properly prepared, the steel made in it has a considerable running life. On the Continent small furnaces of 1 or 2 tons capacity are employed for this type of work very successfully. Usually such furnaces are not made with a greater capacity than about 6 tons.

Acid Electric Steel

The properties of acid electric steel have been investigated by Sisco, who claims that it is best for light castings, weighing 200 lbs. or less, especially where high production and economy of operation are of prior importance. He claims that it gives steel with a power consumption of about 10 per cent. less than that necessary in basic practice, whilst the cost of refractories is appreciably lower for the acid steel. It is, however, desirable to limit the application of electric steel to cases where refining is not necessary, where sulphur and phosphorus need not be particularly low, where there is a plentiful supply of good scrap, where the specified analysis permits of considerable variation, and where there is little call for alloyed steels. In addition, acid steel is applicable where the property of high surface tensions possessed by the acid slag is of importance, for example, in cases where it is desired to pour over the lip either of a ladle or of a shank.

In furnaces of the Héroult type all the electrodes are fixed above the surface of the bath, arcs being struck between each electrode and the bath. In electric furnaces of the Electro-metals type, on the other hand, one of the electrodes is situated in the bottom of the furnace, below the bath. Basic refractories of the magnesite type become sufficiently good conductors of electricity at high temperatures to allow the electric current to be conveyed from electrodes above the bath to an electrode underneath the bottom of the furnace, but acid refractories, such as silica, remain at high temperatures, insufficiently good conductors to allow the current to be conducted in this way. Consequently, although the change-over from basic to acid working is possible, in the case of Héroult and similar type furnaces, by changing the nature of the furnace lining, it is impracticable in the case of furnaces having a bottom electrode to adopt an acid lining, and this is probably one of the reasons why acid electric steel has made much less progress in this country than in the United States and on the Continent.

Production of Steel Castings

(*Concluded from page* 155.)

tions adjacent to each other, and thus lessens the tendency to pull apart when the light section solidifies and contracts away from the still soft and weak heavy sections.

Because of the difficulty of estimating the amount of chilling required, the use of chills is always a very uncertain measure, and there is always a possibility of causing cracks, one of the particular defects chills are used to eliminate. If the chill is estimated as a greater mass than is really required, then the section is overchilled, and contraction stresses are set up in a manner opposite to that which would have been experienced if no chill were used, with the possibility of a hot tear. If the mass of the chill is less than is required, then it will not attain its object, since solidification will not proceed as rapidly as is necessary to ensure soundness.

Some Criticisms of the Provisional Report of the Costing Sub-Committee

COST OF METAL AT CUPOLA SPOUT

By BERNARD DORAN*

Share of Fixed Charges (rent, rates, depreciation, etc.).—The report says that these are allocated on floor space, but the writer presumes that depreciation of plant (cupolas, cupola-charging crane, etc.) would be calculated on the recorded value of these items as shown by the plant record.

Application of Metal and Melting Cost to a Particular Job.—The report recommends that the melting costs and oncosts should be divided between the classes of castings proportionately to the tonnage of metal melted in each class, thereby to arrive at a cost per ton of good castings produced in each class. The report does not suggest how the figures for the respective tonnage of metal melted may be arrived at, but it is presumed that this could be done by weighing the runners and risers fettled from each class of casting and adding these weights to the total weights of fettled castings produced in each class. This segregation of classes of runners and risers within the foundry would be found practically impossible, but a reasonably accurate figure could be obtained by ascertaining the unfettled weight of all castings produced. Where a foundry was engaged on work of a repetitive nature this would not be difficult, as an average unfettled weight for each casting could be determined, and the quantity of each casting, as shown by the floor check, could be multiplied by this weight.

If this were done, instead of applying to a particular job "the cost of the metal at the spout per ton of good castings produced" (which cost would vary according to the yield of the class of castings to which the job belonged)—the unfettled weight of the particular castings pertaining to the job—multiplied by the cost of one ton of metal leaving the cupola spout would be the metal and melting cost for the job, after deducting the weight of runners and risers at "home scrap" price.

Moulding Boxes

The report recommends as follows:—(*a*) Where moulding boxes are made for a particular job, then their cost is a direct charge against the job, and (*b*) general moulding boxes are charged to a "box part account" which would be liberally depreciated and the depreciation charged as a moulding-department overhead. This account should be credited with the scrap value of discarded boxes at the time they are scrapped.

Several questions arise from the latter sentence of (*b*). The effect of reducing the box part account by the scrap value of the discarded boxes would mean that the depreciation charged as a moulding overhead would be reduced in a month when the worn-out boxes are thrown out and are no longer an asset of the concern. Also, the discarded box might be one whose first cost had been charged to a particular job, but the cost of the job would not be reduced by the return to stock of metal with which the job had been charged.

Further, the list of overhead expenses given at the end of the report shows an item for "box parts," divided into labour and materials. Earlier in the report the recommendation that the "box part account" should be depreciated, and the depreciation charged as an overhead suggests that this account represents an asset, not an expense. It is evident that labour, materials and depreciation cannot all be charged as overheads under the heading.

* Cost Accountant Sterling Metals, Limited, Coventry.

Direct Labour Cost

Simple though the proposition sounds, it is not always possible accurately to record the wages cost of a particular casting, or batch of castings. In this district it is the practice, since the moulders cannot be paid less than their district day-rate, plus cost-of-living bonus, to set the total piecework earnings of any man against his day-rate wages for the hours worked on piecework, and a piecework balance arrived at, which, when added to his day-rate wages and cost-of-living bonus, would constitute his total earnings. By this means a "debt" on one job is made up from a "balance" on another. Also, if the total piecework earnings are below the district day-rate for the time worked, the day-rate wages paid would be increased from the pieceworkers' to the dayworkers' scale. Applying this to the case of a man working on an order for 9 castings "A" and 15 castings "B" in one week, and at some future time working another week on an order for 18 castings "A" and 8 castings "B," the wages paid would be as shown in the table in column 2.

This example shows a difference between the two orders of 1d. each in the case of "A's" and 4d. each in the case of "B's" although the rate of production was practically the same for the two orders.

If it were decided to add to the cost of "B's" the whole of the additional 2s. 6d. per 47 hrs. paid in the case of the first order, then the difference is greater. Neither of the orders would reflect the true cost of the jobs, nor be any guide for fixing selling prices, since the apparently high piecework price paid for "A's" and the low price for "B's" would result in peculiar costs being recorded if a whole week were spent in the production of "A's" or "B's" alone. Instances such as this can arise either from an error in fixing piecework prices, the workman being more experienced in producing "A's" than "B's," or the tackle for producing "B's" being inefficient.

1ST ORDER—

	Hours worked.	Made.	Scrap.	Good.	P.W. price each.	£ s. d.
Castings "A"	15	10	1	9	3s.	1 7 0
" "B"	32	20	5	15	1s.	15 0
Total ..	47	Total P.W. ..				2 2 0
		Day rate for 47 hrs.				2 5 0
		Debt ..				3 0

WAGES PAID.

47 hrs. at day-worker's rate	2 7 6
" cost-of-living bonus	12 0
	£2 19 6

WAGES—COST OF CASTINGS.

"A's"—9 at 3s. each	1 7 0
Plus 15 hrs. cost-of-living bonus, at 12s. per 47	3 10
" 15 hrs. at additional 2s. 6d. per 47 ..	9½
	1 11 7½
	= 3s. 6d. each.
"B's"—15 at 1s. each	15 0
Plus "Debt" paid	3 0
" 32 hrs. cost-of-living bonus at 12s. per 47	8 2
" 32 hrs. at additional 2s. 6d.	1 8½
	1 7 10½
	= 1s. 10½d. each.

2ND ORDER—

	Hours worked.	Made.	Scrap.	Good.	P.W. price each.	£ s. d.
Castings "A"	30	20	2	18	3s.	2 14 0
" "B"	17	10	2	8	1s.	8 0
Total ..	47	Total ..				3 2 0
		Day rate for 47 hrs.				2 5 0
		P.W. Balance ..				17 0

WAGES PAID.

Day rate, 47 hrs. at 45s.	2 5 0
P.W. balance	17 0
Cost-of-living bonus, 47 hrs. at 12s.	12 0
	£3 14 0

WAGES—COST OF CASTINGS.

"A's"—18 at 3s. each	2 14 0
Plus 30 hrs. cost-of-living bonus at 12s. per 47	7 8
	3 1 8
	= 3s. 5d. each.
"B's"—8 at 1s. each	8 0
Plus 17 hrs. cost-of-living bonus at 12s. per 47	4 4
	12 4
	= 1s. 6½d. each.

Overhead Application

The example set out under the heading of "Direct Wages" also serves to illustrate the objections to allocating overheads on the basis of productive wages. The difference in the wages cost of the two orders would cause the overheads per casting being greater on the first order than on the second. Where wages for castings are paid for on a piecework basis, payment for faulty castings being withheld, the "productive wages" method of applying overheads fails to charge to the appropriate order the factory expenses incurred in making moulds from which no good casting results. The hourly basis for overhead recovery does seem to overcome most difficulties.

Iron and Steel Output

The British Iron and Steel Federation reports that there were 109 furnaces in blast in the United Kingdom at the end of January compared with 102 at the beginning of the month. The production of pig-iron in January amounted to 595,500 tons compared with 559,300 tons in December, 1935, and 521,200 tons in January, 1935; the month's production included 125,200 tons of hematite, 337,900 tons of basic, 105,100 tons of foundry, and 9,800 tons of forge pig-iron. The production of steel ingots and castings in January amounted to 912,500 tons compared with 811,500 tons in December, 1935, and 757,800 tons in January, 1935.

Problem of Metallic Wear

The Institute of Metals is arranging a special meeting to discuss the subject of "Metallic Wear." It will take place in London on March 10, in connection with the Institute's annual general meeting. The discussion will be opened by Dr. H. W. Brownsdon, with a Paper which reviews some of the major factors involved in metallic wear and indicates a method by which they can be quantitatively assessed. The problems involved interest not only to engineers, but also chemists, physicists and metallurgists. The special aspects of the subject appealing to those workers will be dealt with by contributors to the discussion. As the subject is one of wide interest, members of other institutions—including the Institution of Mechanical Engineers, the Institution of Naval Architects, the Institution of Automobile Engineers, the Iron and Steel Institute and the Royal Aeronautical Society—have been invited to attend the meeting and to take pare in the discussion. Cards of invitation may be obtained from Mr. G. Shaw Scott, M.Sc., Secretary, The Institute of Metals, 36, Victoria Street, London, S.W.1.

The Technique of Chilling

ROLL MANUFACTURE FEATURED

The January meeting of the Newcastle Branch of the Institute of British Foundrymen, over which Mr. James Smith presided, was very appropriately preceded by a visit to the works of Sir W. G. Armstrong, Whitworth & Company (Ironfounders), Limited, because during an interesting and instructive tour through the roll department the practical application of chilling was seen, and the business of the evening was to hear a Paper by Mr. J. Roxburgh, entitled "The Technique of Chilling." This Paper has already appeared in the FOUNDRY TRADE JOURNAL dated April 11, 1935.

In throwing the meeting open to discussion, the BRANCH-PRESIDENT remarked that he had taken the greatest interest in the visit paid to Close Works in the afternoon, and he felt that the Paper would be all the more appreciated by the members who had taken part, and who were present at the meeting.

Chill Reeking in Acetylene Flame

MR. J. H. COOPER raised the question of the test-pieces to which reference had been made. He asked at what temperature the lecturer preferred to cast his test-pieces in relation to the ultimate casting of the roll, and also what temperature was considered to be the best for the cooling process. Another question was whether they should be cooled in dead cold water, or should the chill be taken off the water. He said that he had known test-pieces fail when the former method of cooling was adopted. Mr. Cooper mentioned that in some cases on the Continent it was the practice to burn dissolved acetylene as a substitute for blacking. This gave a very clear smoke for coating the inside of the chill. The reason for the use of acetylene in preference to blacking was, apparently, to overcome the liability of flaking off to which the latter is subject. With regard to loam, he mentioned that in certain cases the loam tended to creep away from the chills. What kind of loam should therefore be used in order to avoid this occurrence? The question of the method of drying the wall of the chill before casting was raised, and whether provision was made for vents to allow the escape of steam or gas.

Blackings in Roll Practice

MR. ROXBURGH replied that the temperature for casting test-pieces was largely based on experience. For instance, the temperature of metal in an air furnace would be in the region of 1,370 or 1,380 deg. C., and it had not been found necessary to record the actual temperature at which the test-piece should be cast. The metal was allowed to cool down to a certain temperature judged by experience; if cast too hot, too deep, a chill would result. Referring to the effect of cold water on the quenching of the test-piece, he said that he had never experienced any difficulty in that connection, and the same practice was employed in both winter and summer without any ill effects.

With regard to the question of blacking the chill with dissolved acetylene, he had never seen this done, although on the Continent he had found that in some cases, after blacking the chill, they had used a little so as to give a carbon film on the top of the blacking. He was not aware of its being employed altogether for the coating of chills. He had, however, noted with interest the method described by Mr. Cooper. He said that if the chill was clay-washed, and also clay-wash mixed with the blacking, the resultant skin of the casting was quite smooth and clean, but as soon as machining operations were commenced, pinholes were found. Within his experience he had found that a high carbon blacking mixed with molasses gave the best results.

Loam Practice

Dealing with the subject of loam on a chill, Mr. Roxburgh said that, with a grain roll with the grooves "cast in," he was in the habit of using compo-loam. With a straight-bore chill on which it was desired to strike $\frac{1}{4}$-in. chills, it was necessary to saw-cut the chill in order to get the vent away from the loam. The loam used was a very special mixture, consisting of a very good refractory material, and the ordinary loam or foundry loam would not be suitable for such work. He was not at liberty, however, to divulge the exact nature of this material. On the smaller chills an ordinary type of loam would answer, but in the case of a larger roll, a very special refractory was required, as otherwise it washed off or burnt on.

Repeated Use of Chills

MR. C. GRESTY remarked that, although he had no experience whatever with chilled rolls, yet, so far as the chilling of dry-sand castings was concerned, he had had considerable experience. He wished to know what the effect was of repeated use on the chills themselves: how many times could the chill be used safely, and was there any way of treating them in order to prolong their life? With regard to large chills which were used for chilled rolls, did these ultimately crack or flake off?

He recalled that on one occasion, when making certain castings which were fairly heavy, being 6 to 8 in. thick, it was considered desirable to chill them, although a densening effect was required rather than an actual chill. The chills used, however, were undoubtedly too light, and were covered with a quantity of white powder, which had also penetrated to some extent inside the chills themselves, and the chills were in an extremely bad condition. He then referred to the manganese and sulphur ratio as depicted in the table, and inquired whether the ratio possessed any real significance.

He next referred to the pouring temperature, and to the lecturer's statement that the higher the temperature the greater was the chill on a test-piece, yet, when casting the rolls themselves at a lower limit of temperature, a heavier chill would be obtained. What was the explanation of this seeming paradox?

Life of Chills

MR. ROXBURGH, replying to the point regarding the repeated use of the chills for foundry castings, said that they required careful examination after each cast, and frequently the chills were discarded after about four casts. Concerning the deterioration of the chills which Mr. Gresty had observed, he could make no statement, as he had never experienced this.

At this point MR. J. H. COOPER pointed out that on the Continent he had observed a practice whereby the chills were bored out at the back with a number of holes. He did not know the reason for this, but he believed that it was very good practice and had some effect on the life of the chills. MR. SCOTT confirmed this view.

Surface Cracking

Referring to the subject of chills for chilled rolls, MR. ROXBURGH said that, due to the expansion and contraction, and to the fact that it was made of hematite, an ingot mould, after it had been used several times, would be found to have a "crocodile" appearance, *i.e.*, cracks all over the surface. This was caused by the graphite flakes forming an inroad along which oxidation could take place. Ferrite and graphite were likewise present in a hematite chill, and the alternate heating and cooling finally resulted in the chill presenting a very cracked appearance.

With regard to the life of chills for solid rolls, that was, as contrasted with hollow rolls, he had obtained on the smaller chills a matter of 50 out of the chill, whereas with the larger diameter rolls, probably 25 would be obtained. The figures given for the manganese and sulphur ratio were based on the experience which he had had with the range of irons shown.

Regarding the question of the temperature of casting, the test-piece and the resultant chill obtained as compared with the temperature of the casting of the actual roll and the chill thrown, it was to be noted that with a chilled test-piece, one was dealing with a small casting, and the higher the temperature the greater was the rate of cooling. Heat was being extracted more rapidly, and this resulted in a deeper chill. With a roll, however, mass action was involved, and the higher the temperature of casting, the less the chill.

Temperature of the Chills

MR. W. SCOTT asked if there were any importance attached to the temperature of the chills themselves as no mention had been made of this, although five reasons had been given for controlling the chill depth in the rolls. He also inquired whether there was a technical explanation to offer for the fact that some customers wished to know the direction of the spin of the metal when poured.

MR. ROXBURGH stated that he attached no importance to the temperature of chills. To the latter question he replied that he had never before encountered such a thing, and as long as the rolls gave good service, the direction of spin of the metal was never questioned. He felt, however, that it was a point worthy of investigation.

MAJOR F. BIRD then raised the subject of raw materials, and inquired whether two analyses, being identical, would give the same chill depth.

The LECTURER in reply, said that the chill test could only be used as a comparison when similar metals were used in mixture. Composition, however, was not everything; structure was more important, and also the materials which went into the mixture in the cupola. He expressed the belief that composition was merely a guide, and it was the materials comprising the mixture which were of importance. He agreed that to be definitely accurate, it would be far better to get the different compositions with the same materials in order that the different compositions might be compared. The analyses on the table were merely given as examples.

Vertical Cracking

MR. E. A. TAIT asked whether, in the lecturer's opinion, a vertical crack in a roll was due to some physical cause giving an uneven chill on the roll, rather than to its being due to the metal. What were his views on the value, or otherwise, of a long or a short mottle on a roll?

MR ROXBURGH replied that in his experience he had always associated a vertical crack as being due to the metal. He agreed that there were several reasons which might cause an uneven chill; for instance, if due to some physical force, the roll were kept in contact with one side of the chill after contraction, it would naturally result in a deeper chill on that side of the body of the roll than on the other. He found that vertical cracks were eliminated by an alteration in the metal. Therefore, essentially, a vertical crack could be traced to the metal. Regarding the question of mottle, he would only say that a medium mottle was considered to be the best. For example, on $\frac{3}{4}$ in. chill depth, a mottle in the neighbourhood of $\frac{3}{8}$ in. is of great benefit to the roll. With $\frac{3}{4}$ in. chill depth and $\frac{5}{8}$ to $\frac{3}{4}$ in. mottle, the roll would

(*Concluded on page* 164.)

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W21

Foundry Refractories

INFLUENCE OF FURNACE DESIGN ON LIFE

Mr. W. Hamilton's Paper* on "Refractories in the Foundry," which he read before the Scottish Branch of the Institute of British Foundrymen, brought out a few interesting pointers, especially as to the influence of design on the life of cupola refractories.

The discussion was opened by the BRANCH-PRESIDENT (Mr. Daniel Sharpe), who said they had listened to an interesting Paper and had the opportunity of seeing some helpful illustrations. As he had ventured to suggest, Mr. Hamilton had handled the subject very fully and had raised several contentious points.

MR. DUNLOP said he was using a reverberatory furnace for the melting of non-ferrous metals, and found that the brick joints, particularly on the bottom of the furnace, were badly affected after a very few melts. The cracks were very wide and it was difficult to repair the lining. The furnace was of 6 tons capacity, coal-fired, using forced draft for preheating and slagging *only*. Fireclay was used for cementing the joints. What was the best means of patching the furnace?

MR. HAMILTON said he would recommend him a change over to a monolithic lining. He thought the results would be better, as there would be no joints to corrode. He advised the use of a refractory cement for patching in place of fireclay.

MR. DUNLOP said he had not tried a rammed bottom, but he had patched with refractory cement and the lining was as bad again after one melt.

MR. HAMILTON observed that unless the bricks were thoroughly cleaned of slag the high-temperature cement would be useless. He advised Mr. Dunlop to try high-alumina bricks to get over his difficulty. They were more expensive in the first place, but the benefit was reaped in the longer life of the lining.

MR. J. CURRIE said he would like more information about the use of Chamotte. Regarding the use of cement he would be glad to have any information which Mr. Hamilton could give. These were two special processes which might or might not develop in steel foundry practice. In connection with oil-sand work would he advise that the sand be washed or unwashed? His own views were that for Tropenas or Stock converter steel, washed sand gave better results, but for open-hearth steel unwashed sand was better. The unwashed sand was about half the price of the washed sand, and so if unwashed could be used there was a big inducement on cost. He thought that in giving the temperature of the steel at 1,580 deg. C. he was on the low side and it should be about 200 deg. C. higher. He was satisfied about rammed linings for converters but he would like to know if Mr. Hamilton would recommend the ramming of a Siemens furnace.

MR. HAMILTON said that Chamotte was something quite new and it was a calcined clay mixed with an uncalcined clay of the same type. For heavy castings, especially steel castings, there was nothing to equal it. The grading was three-sixteenths to one-eighth, so there was no danger of gases being trapped after the mould was full. As to oil-sand, some people preferred sea sand and some silica sand washed or unwashed. Washed sand was probably best for general work and small castings, but for open-hearth steel he thought the unwashed as good. In fact unwashed sand would probably answer for all purposes. The price did not vary much and there was really nothing to worry about on that score. In connection with the ramming of open-hearth furnaces all the ports could be rammed quite successfully and that was the place where all the damage was done. He was hardly prepared to recommend the ramming of the interior of the furnace at present.

MR. KIRBY said Mr. Hamilton advocated the use of 60 per cent. old sand with 40 per cent. new and he thought that was too generous an allowance. He used only 15 per cent. of new sand and got quite satisfactory results, provided the regenerated sand was properly dedusted. In regard to the use of cement-bonded sand Mr. Hamilton had stated it caused the metal to tear, but in America it was being used and one of the reasons given for its use was to stop tears. As far as relining the converter weekly instead of patching daily was concerned that would depend entirely on the number of blows. If they made 17 heats per day it had to be patched every morning.

MR. HAMILTON said that perhaps 40 per cent. new sand was rather a generous amount and he was glad to know Mr. Kirby could use 15 per cent. and achieve satisfaction. He thought, however, there was nothing like playing for safety in the foundry. Regarding cement for bonding what he had used was a Continental cement and it certainly did not eliminate tears. As to relining converters, perhaps Mr. Kirby referred to a Tropenas whilst he referred to the Stock converter, the former with about 15 heats against only 4 per diem for the latter. He maintained that by weekly patching they got a new lining every week.

MR. KIRBY said the point he wished to stress about the relining was that it was impossible to go for a whole week without patching. He quite agreed that rammed linings were equal, if not superior, to bricked linings. MR. HAMILTON said he had no doubt about the weekly patching being the best. MR. CURRIE said it was not possible to patch a Stock converter, because the men knocked the patch off in charging. MR. HAMILTON pointed out that one could if one used two vessels on alternate days.

The CHAIRMAN said that there were one or two points which Mr. Hamilton had raised which interested him. He had stated that Mansfield sand was the cure for many of the troubles in the foundry. He quite agreed with that statement, but the price of the cure was prohibitive in the West of Scotland on account of the high carriage. If it could be had in Glasgow at a reasonable price, it would be satisfactory. He had hoped that someone would have given information as to brick *versus* rammed cupola linings. He would have liked to have heard the experiences of someone who had tried the monolithic lining. In referring to the use of cement in moulding sands, he wondered whether Mr. Hamilton referred to a refractory cement or to Portland cement in moulding sands. He had had some tests carried out lately in the use of cement and he would encourage further investigation in that direction, as he thought there was something to be had from the use of cement of good quality. He wished to warn them that it must be good Portland cement, as slag cement was useless and led to much trouble and disappointment.

MR. HAMILTON said Portland cement was mixed for steel castings, but the cement he referred to was a refractory cement.

MR. F. HUDSON said Mr. Hamilton's Paper contained some sound points. He agreed with some of them, and urged further attention to others. Mr. Hamilton had given a preference for an oil wash instead of clay or blackwash. The remarks referred particularly to steel, but could apply to iron. The permeability of sands for oil-sand cores was about 200, but after blackwashing it was reduced to about 6. What then was the good of going to the trouble of finding a good sand and spoil it with an unsuitable wash? In many castings the best results were not obtained because of improper washes. The same thing applied to dry-sand moulds. An oil wash did not affect the permeability of the sand. Experiments that had been made showed that an oil wash sprayed on would be the wash of the future.

He had tried every kind of rammed lining and every type of brick. He did not wish at that time to enter into details of the respective merits. He had recently tried the 40 to 45 per cent. alumina bricks, which were a departure from the ordinary bricks, which had only 30 to 35 per cent. He had hoped to have obtained better results from these bricks, but so far had found no benefit. He was inclined to think that the refractory life of the lining was considered from the wrong angle. They were too ready to blame the refractory instead of the cupola designer. He believed the design of the cupola or the way it was worked caused most of the trouble. The practical men should set to work and do his best to relieve the stresses on the refractory. It was quite a common experience with him to get an 8-in. lining loss on a 50-ton blow, and as he had only a 9-in. lining and blows of 70 tons, it meant having men standing by with hose pipes to cool the shell in case of a break-out. He had a modern furnace installed not long ago, but it did not give an even air distribution, so the lining was badly cut on one side. By rearranging the air distribution, the lining loss had been reduced to 4 in. without changing the refractory. He therefore advised them not to blame the refractory too readily, but to set to work to combat the causes of the wear.

The PRESIDENT said Mr. Hamilton had given them information which would be extremely useful to all. He extended to Mr. Hamilton the thanks of the members for having given a practical Paper of so much interest.

* FOUNDRY TRADE JOURNAL, January 30, p. 101.

The Technique of Chilling

(*Concluded from page* 162.)

be inclined to be brittle, and if there was only ⅛ in. mottle on the back of the chill it would be too defined.

Influence of Superheat

MR. SCOTT gave an instance of two exact charges, one of which was melted in the furnace and tapped at 1,370 deg. or 1,380 deg. C., then held to correct pouring temperature and poured. The other charge, exactly the same in every detail, was melted at 1,550 deg., allowed to cool down to the same figure and poured into another roll of the same size. In a case of that nature, would the chill be the same on both rolls?

The LECTURER replied that he had had no experience in that particular direction, but that the degree of superheat had an effect on cast iron. A certain type of roll was made on the Continent, and instead of melting in the rotary furnace to a temperature of 1,500 or 1,600 deg., the practice was simply to melt the iron to 1,370 or 1,400 deg. C., as in cupola practice. He was of the opinion that the iron had sufficient superheat and could be dealt with more quickly, and although personally he had no definite knowledge of it, he thought that it would have a slight effect on the chill. The metal he referred to had been found excellent for flour rolls.

Referring to the question of temperature, he said that when past 1,400 deg. and even higher temperatures, certain alterations took place which altered the physical structure of the resultant roll. In making steels, which have to be taken to a certain temperature, certain reactions took place. The various elements were all affected, more or less, at varying temperatures, and the point to be aimed at was to prevent oxidation from taking place if possible.

A vote of thanks was proposed by MR. GRESTY and seconded by MR. COOPER and heartily carried.

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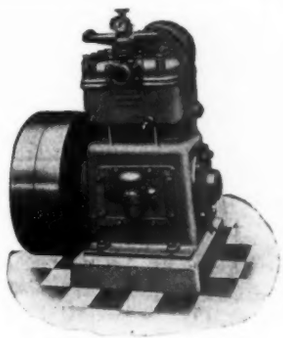

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This Week's News in Brief

Trade Talk

PLYMPTON ST. MAURICE'S peal of church bells has been taken down, after one hundred and sixty-eight years, for recasting at J. Taylor & Company's foundry at Loughborough.

ENGINEERING STUDENTS from Loughborough College are to visit the workshops of the General Aircraft, Limited. An air liner will take the students from Leicester to Feltham, Middlesex.

OWING TO AN OUTBREAK OF FIRE, work was temporarily stopped at Mr. Joseph Toole's West End Ironworks in Middlesex Road, Oldham. The damage will not, however, interfere seriously with production.

RUSSIAN ORDERS were a feature in Motherwell steel mills last year. It is, therefore, significant to note the recent arrival at Glasgow of a shipment from Leningrad of 2,500 tons of pig-iron for use at the Motherwell mills.

FERGUSON BROTHERS (PORT GLASGOW), LIMITED, have received an order from the Port of London Authority for the construction of two wreck-lifting vessels of special design, each complete with powerful winches and pumping-out plant.

FOR SOME WEEKS Grangemouth docks have been the scene of increasing activity, due to the improved conditions in the iron and steel works of the West of Scotland. Daily numerous vessels have been arriving laden with pig-iron, scrap and iron ore.

JOHN G. KINCAID & COMPANY, LIMITED, Greenock, have contracted to supply and fit on board the machinery required for two tankers, which are to be built on the North-East Coast. The machinery will consist of a set of ten-cylinder Burmeister & Wain-Harland & Wolff-type Diesel engines for each ship.

EMPLOYEES AND STAFF of Muirhall Foundry, Larbert, held their annual social meeting on February 6. Mr. Robert Taylor, managing director, presided over the social proceedings, which were sponsored by a concert party led by Mr. R. McCowan, and followed by a dance at which Mr. William Bain acted as M.C.

WILLIAM DENNY & BROTHERS, LIMITED, Leven Shipyard, Dumbarton, have received an order to build a vessel with a deadweight capacity of 9,000 tons for P. Henderson & Company, Limited, for cargo and passengers on the Rangoon service. The vessel will be single-screw driven by turbines through single-reduction gearing.

AN OFFICIAL STATEMENT issued by the company states that Colvilles, Limited, have decided to take over 50 per cent. of the issued share capital of the Steel Company of Scotland, with an option to acquire the balance save for a small block of 150 shares. Previously the firm announced its intention to absorb almost all of the share capital of that company.

A CONTRACT for four fusion-welded boilers has been received by Babcock & Wilcox, Limited, Renfrew. These boilers, which develop a pressure of 650 lbs. per sq. in., are of a new type, and are for service at the Clarence Dock electricity power station, Liverpool. Extensions are to be made to the firm's iron and steel foundries, and it is expected that the operations will be completed by next June.

THE SHEFFIELD AND DISTRICT ENGINEERING TRADES EMPLOYERS' ASSOCIATION, at their annual meeting, elected Mr. S. Osborn as President, in succession to Mr. F. C. Fairholme, who has retired from the office, which he held for the last four years. Lord Riverdale, Mr. P. B. Brown, Mr. A. J. Capron, Mr. A. J. Grant, Mr. T. W. Willis, Mr. A. B. Winder, and Mr. George Baker were elected Vice-Presidents.

AS FORECAST by Mr. Ashley S. Ward at the Gainsborough Annual Trade Dinner on Tuesday evening of last week, an immediate announcement is to be made regarding Marshall, Sons & Company, the famous Gainsborough firm, whose works and assets were recently acquired by Thos. W. Ward, Limited, Sheffield, of which firm he is joint managing director, and a new company under the old name will endeavour to restore the business to its former importance.

A COMPLIMENTARY DINNER was given by the management of Thos. W. Ward, Limited, of Sheffield, to the management of the Laycock Engineering Company, of Millhouses. The progress of this old-established firm has been most successful under the management of Thos. W. Ward, who have now parted with the works to an independent company, the Laycock Engineering Company, Limited. Mr. Joseph Ward, chairman of Thos. W. Ward, Limited, presided over a gathering of 120, and was supported by directors from each company.

THE ANNUAL DINNER of the Carron Company, which, owing to the death of King George V, had been postponed from January 25, was held in the Dobbie Hall, Larbert, on February 8. Mr. George Pate, O.B.E., general manager, presided over a large company. In the course of his speech, the chairman reviewed the business conditions during the year and trade prospects for the various sections of the company's business for the coming year. Mr. Simon Fraser, joint foundries commercial manager, proposed the toast of the Carron Company. A "Nicht wi' Burns" programme was carried out after dinner.

A MAGNESIUM METAL and alloy factory is to be established at Clifton, near Manchester, by Magnesium Electron, Limited, the £500,000 concern associated with F. A. Hughes & Company, Limited, of London. The factory will be partly housed in buildings formerly used by the L.M.S. Railway as a power station. Something like 50,000,000 units of electricity will be required annually, and contracts have already been arranged with the Lancashire Electric Power Company, whose principal station is at Kearsley, about two miles distant. It is officially understood that the new factory will not be in full commission until September.

THE ELECTRIC FURNACE COMPANY, LIMITED, of 19, Victoria Street, London, S.W.1, together with its associated concerns, on the occasion of its staff dance, invited a number of people prominent in the metallurgical industries to join them. The guests, who numbered about 180, were received by Mr. and Mrs. D. F. Campbell at the Westminster Palace Rooms. Amongst those present were Mr. and Mrs. W. A. C. Newman, Professor and Mrs. Merrit, Mr. V. C. Faulkner (Past-President of the Institute of British Foundrymen) and Mrs. Faulkner, Mr. and Mrs. A. J. Murphy, Mr. and Mrs. W. T. Griffiths, and Mr. and Mrs. J. F. Kayser. Mr. Campbell was ably assisted in his duties by Mr. W. S. Gifford and Mr. G. E. Taylor (directors of the Electric Furnace Company) and by Mr. F. E. Connor, publicity manager.

Obituary

MR. ANDREW GRAY, who retired from the managership of the Lanarkshire Steel Company, Limited, Motherwell, a few weeks ago, died recently at Biggar. He was granted an M.B.E. for war services.

MR. SOMMERVILLE CHALMERS, who has been employed at Fullwood Foundry for many years, and who only recently succeeded to the managership, died suddenly on February 6 at Fullwood Foundry House, Mossend, Lanarkshire.

MR. H. E. FULTON, late joint managing director of Albion Motors, Limited, died at his residence at Bearsden on February 8. Mr. Fulton commenced his business career in the firm of Fulton & Weir, of which his father was senior partner.

Company Reports

Clarke, Chapman & Company, Limited.—Dividend of 6 per cent. for the past year.

Thos. W. Ward, Limited.—Interim dividend of 2½ per cent. on the ordinary shares.

Baldwins, Limited.—Dividends of 6 per cent. per annum on the 6 per cent. "A" preference shares for the half year ended December 31, 1935, and of 7 per cent. per annum on the 7 per cent. "B" preference shares for the year ended December 31, 1935.

Mather & Platt, Limited.—Final dividend of 7 per cent., making 10 per cent. on the ordinary stock for the year to December 31 last. A bonus distribution of 2 per cent., tax free, is also recommended on the ordinary stock on account of realised capital profits, which will absorb £27,273.

Contracts Open

Buenos Aires, March 11.—Motor pumping set, for the Argentine State Oilfields Directorate. The Department of Overseas Trade. (Reference T.Y. 5,696.)

Beddington, February 24.—Iron castings, for the Beddington and Wallington Urban District Council. Mr. S. F. R. Carter, engineer and surveyor, Town Hall, Wallington, Surrey.

London, E.C., February 26.—Cast and spun iron straight pipes and cast-iron specials, for the Metropolitan Water Board. The Chief Engineer, Offices of the Board, 173, Rosebery Avenue, E.C.1.

Gosberton, February 24.—Construction, completion and maintenance of 2,160 lineal yards of 3-in. diameter cast-iron pipes and sluice valves, etc., for the Spalding Rural District Council. Mr. E. J. S. Maples, clerk, Council Offices, New Road, Spalding, Lincs. (Fee £3, returnable.)

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

Clough (Croydon), Limited.—Capital, £7,500. Engineers, founders, etc. Subscriber: H. F. Perry, 8, Park Grove Road, London, E.11.

Bideford Black Pigments, Limited.—Capital, £100. To search for and dispose of mineral black, carbon, coal, etc. Subscriber: H. St. L. Cookes, 25, Wetherby Mansions, Earl's Court Square, London, S.W.5.

Flavell & Churchill, Limited, Bellott Street, Blackheath, London, S.E.3.—Capital, £3,500. To take over the business carried on by J. Churchill, and to carry on the business of ironfounders, mechanical engineers, etc. Directors: C. S. Broughton and B. H. E. Broughton.

Forthcoming Events

FEBRUARY 21.

Institute of Mechanical Engineers:—Annual general meeting at Storey's Gate, St. James's Park, London, S.W.1, at 5.30 p.m.

FEBRUARY 28.

The Manchester Association of Engineers:—"The Manufacture and Application of Modern Cast Irons," Paper by J. W. Gardom, at the Engineers' Club, Albert Square, Manchester, at 7.15 p.m.

MARCH 4.

Manchester Metallurgical Society:—"Fusion-Welded Pressure Vessels." A Paper by S. F. Dorey, D.Sc., at the Engineers' Club, Albert Square, Manchester, at 7 p.m.

MARCH 5.

Institute of Metals (London Local Section):—"Patent Law—With Special Reference to Non-Ferrous Metals." A Paper by G. S. W. Marlow, B.Sc., at the Motor Manufacturers & Traders, Limited, 83, Pall Mall, London, S.W.1, at 7.30 p.m.

Institute of British Foundrymen

FEBRUARY 21.

Sheffield and District Branch:—"Sand and Shot Blasting." Paper by J. H. D. Bradshaw at the Grand Hotel, Sheffield, at 7.30 p.m.

Middlesbrough Branch:—A Paper by G. B. Bidler at the Cleveland Scientific and Technical Institute, Corporation Road, Middlesbrough, at 7.45 p.m.

FEBRUARY 22.

East Midlands Branch:—"Non-Ferrous Castings." Paper by A. Logan at Loughborough College, Loughborough, at 6 p.m.

Newcastle-upon-Tyne and District Branch:—"Foundry Products through the Microscope." Paper by E. B. Ellis at Neville Hall, Westgate Road, Newcastle-upon-Tyne, at 6.15 p.m.

FEBRUARY 29.

Scottish Branch:—"Foundry Coke." Paper by Prof. H. L. Riley, at Temperance Café, Lint Riggs, Falkirk, at 6 p.m.

MARCH 4.

Birmingham, Coventry and West Midlands Branch:—Works visit. "The Applications of Pulverised Fuel," by H. E. Cookson, at Coventry.

London Branch:—"The Possibilities of the Electric Furnace in the Cast-Iron and Brass Foundry." A Paper by A. C. Robiette at the Charing Cross Hotel, Charing Cross, London, W.C.2, at 8 p.m.

The Institute of Vitreous Enamellers

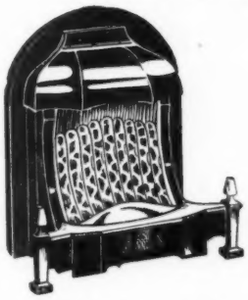
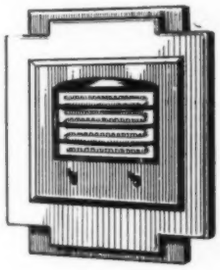
MARCH 5.

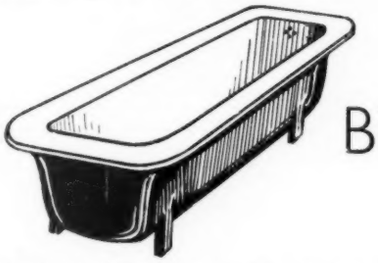
Manchester:—"Enamel Mill-room Practice and Equipment." A Paper by G. Steele, at the Y.M.C.A., Peter Street, Manchester, at 7.30 p.m.

HOLWELL IRON

the recognised brand for

VITREOUS ENAMELLING

THIS  CLEAN MELTING 

FLUID PIG IRON  BY VIRTUE

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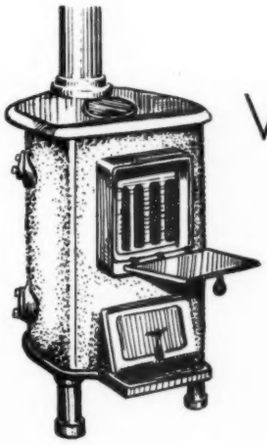
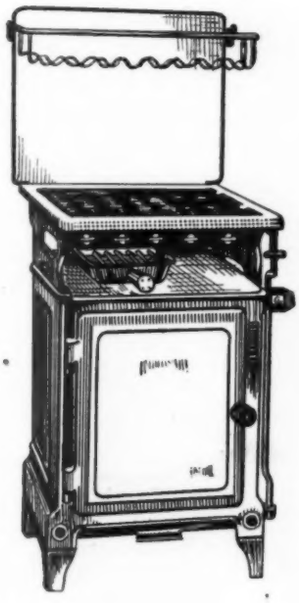
IS IDEAL FOR  VITREOUS 

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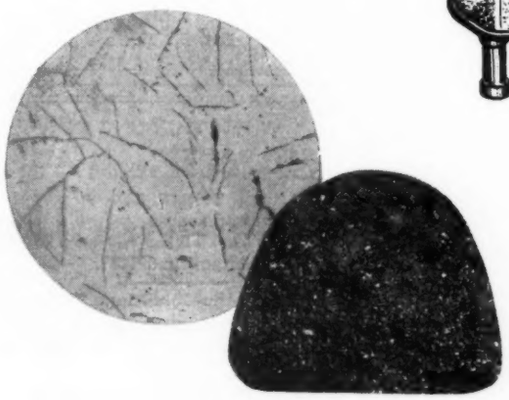

ANALYSIS

	%
Graph. Carbon	3.16
Comb'd Carbon	0.3
Total Carbon	3.46
Silicon	3.0
Sulphur	0.02
Phos.	1.35-1.55
Mang.	0.44

The Stanton Ironworks Company Limited, Near Nottingham

The Largest Producers of Foundry Pig Iron (for sale) in Great Britain

Raw Material Markets

The January output figures of iron and steel revealed a new high level for steel. The output of pig-iron was the highest since 1929. At the present time makers are not keen sellers and consumers, for their part, being well covered for supplies, can wait before entering into contracts for substantial tonnages. As soon as the question of prices is settled new business is likely to be received on a greatly increased scale. It is generally expected that quotations for pig-iron and steel will follow hematite and be raised in the near future. Output of pig-iron is being still further increased, but stocks have been heavily drawn upon recently.

Pig-Iron

MIDDLESBROUGH.—Supplies of pig-iron for prompt delivery are unobtainable in the Cleveland area and many users who have contracted for their requirements are complaining of late deliveries. No export business has been arranged recently. The steelworks continue to have increasing needs. Three additional blast furnaces are to be lighted up in the near future, but it is expected that only one of these will be used for the production of foundry iron. Prices are unchanged, but almost nominal, No. 3 Cleveland G.M.B. being quoted at 70s. per ton delivered Middlesbrough or Falkirk, 72s. delivered North-East Coast and 73s. delivered Glasgow.

Deliveries of hematite are reported to have been maintained satisfactorily, but an increased output could be absorbed without difficulty. It is still possible to obtain small parcels for prompt delivery. Prices were advanced recently, but further alterations are not out of the question. The minimum figure over the whole of the North-East Coast area and Scotland for No. 1 East Coast quality is 77s. per ton. Prices have thus been increased 6s. per ton in the Middlesbrough area, 5s. on Tyneside, 3s. 6d. on the North-East Coast and 3s. in Scotland.

LANCASHIRE.—Inquiries for new business have not been very numerous recently, but deliveries into consumption locally have been satisfactory. Little improvement has been noticeable in the demand from textile machinists, but the jobbing foundries, the light-castings makers and the machine-tool and certain speciality trades have continued to take deliveries of pig-iron on a good scale. For delivery to consumers in the Lancashire price zone, offers of Staffordshire and Derbyshire brands of No. 3 foundry up to the end of June are on the basis of 78s. per ton, with Northamptonshire at 76s. 6d. Deliveries after June 30 are at 5s. per ton more than the foregoing figures. Scottish pig-iron is still quoted at 83s. 6d. per ton for delivery in the Manchester district. Hematite quotations are 85s. 6d. per ton, delivered equal to Manchester, for East Coast brands, and 86s. for West Coast material.

MIDLANDS.—There continues to be a good demand for ordinary quality foundry iron in this area. Deliveries during January were about the highest since 1934. Prices remain unchanged, the minimum Association figures delivered this area being 72s. 6d. for Northants No. 3 and 75s. per ton for Derbyshire, Lincolnshire and North Staffs No. 3. A small sliding-scale rebate is allowed to large users. Most makers are asking for a 5s. premium for contracts extending beyond the end of June. The general engineering and jobbing trades continue to have heavy requirements of special quality irons. Prices of these irons are not controlled, and vary considerably, according to the quality and transport costs. Makers are rather reluctant to enter into forward business at the present rates, which are:—77s. 6d. to 87s. 6d. for medium-phosphorus iron, 90s. to 97s. 6d. for low phosphorus, and £6 7s. 6d. to £7 15s. for refined iron. Hematite makers are experiencing a heavy pressure for supplies, and deliveries in some cases are belated. Stocks are low on the North-East Coast. Prices are as follow:—£4 7s. 6d. for East Coast No. 3, £4 8s. 6d. for West Coast mixed numbers, and £4 7s. for Welsh mixed numbers, delivered stations in this area, with 1s. 6d. per ton extra if delivered into works in 10-ton lots.

SCOTLAND.—All descriptions of iron are in good request in this area, and difficulty is being experienced in getting supplies of Cleveland foundry. Prices remain unchanged, No. 3 Scottish foundry iron being quoted at 74s. f.o.t. furnaces, with 2s. 6d. extra for No. 1. Sellers of Cleveland iron are unwilling to extend their commitments, and, as a result, increased business has been offered in the Midlands. No. 3 Cleveland is quoted at 70s. f.o.t. Falkirk and 73s. f.o.t. Glasgow, with other English foundry irons 1s. 3d. per ton below these figures. Local steelworks remain fully active, and they would be willing to contract for substantial tonnages of pig-iron, but sellers are reluctant to increase their obligations. Prices of hematite in this area, it is intimated, will be 77s. f.o.t. steelworks for East Coast, West Coast and Scottish material. British and Indian basic iron remains at 70s., less 5s. rebate, delivered steelworks here.

Coke

Deliveries of coke have been more frequent recently. It is generally expected that present supplies will be adequate to cover consumers' immediate requirements. Quotations are still unchanged. For delivery in Birmingham and district best Durham coke is 41s. 6d. to 43s., and Welsh from 38s. to 50s. per ton.

Steel

The recent strong tone of the steel market has been well maintained, and in several departments only the reluctance of the producers to enter into fresh commitments for forward delivery has held the demand in check, says the official report of the London Iron and Steel Exchange. Prices are firm and have a tendency to advance. There is still an acute shortage of semi-finished materials in spite of additional supplies from the Continent. In this department also prices of some descriptions have been increased. The demand shows no signs of slackening, and practically all the producing works are fully booked for some months to come. Business in the finished-steel section of the market continues active, and the official quotations for some classes have been raised during the past week. The home demand continues to absorb most of the production and general export business has been quiet.

Scrap

The tonnages of good heavy melting steel which Cleveland merchants are able to offer continue to be totally inadequate to satisfy the heavy demand and supplies are being imported. The recognised figure is 57s. 6d. per ton delivered works. For machinery cast-iron scrap, 65s. is still the general figure. Ordinary heavy foundry metal is still scarce at 62s. 6d. Conditions on the South Wales scrap market are a little less active. Heavy mild-steel scrap in furnace sizes is quiet at 65s. to 67s. 6d. Good cast-iron machinery scrap for foundry work realises 62s. 6d. to 65s. Active conditions continue to prevail on the Midland market, where all descriptions of scrap are in demand. Heavy machinery in handy sizes is quoted at 60s. to 62s. 6d., while short, heavy steel scrap for foundry purposes is at 62s. 6d. to 65s. delivered works. Firm quotations continue to rule in the Scottish market. Heavy mild-steel melting scrap remains at 57s. 6d., with heavy basic, or heavy iron and steel scrap mixed, at 5s. per ton less. Good, heavy, machinery cast-iron scrap, in pieces not exceeding 1 cwt., is maintained at 67s. 6d. to 71s. 3d., while ordinary cast iron, to the same specification, is at 62s. 6d. to 65s. per ton, delivered f.o.t. consumers' works.

Metals

Copper.—Firmer conditions have prevailed in this market during the past week and consumers have shown considerable buying interest. Confidence has been given to the market by the decision of several of the leading United States producers to raise their domestic sales price to 9½ cents per lb., delivered Connecticut Valley. Another encouraging feature has been the substantial expansion in Continental demand. The British Admiralty have recently purchased about 400 tons of copper.

Daily market prices:—

Cash.—Thursday, £35 2s. 6d. to £35 3s. 9d.; Friday, £35 10s. to £35 11s. 3d.; Monday, £35 17s. 6d. to £35 18s. 9d.; Tuesday, £35 16s. 3d. to £35 17s. 6d.; Wednesday, £35 15s. to £35 17s. 6d.

Three Months. — Thursday, £35 10s. to £35 11s. 3d.; Friday, £35 17s. 6d. to £35 18s. 9d.; Monday, £36 5s. to £36 6s. 3d.: Tuesday, £36 3s. 9d. to £36 5s.; Wednesday, £36 2s. 6d. to £36 3s. 9d.

Tin.—Prices have continued their upward movement and the tone of the market is quite good. New business does not amount to very large proportions, but supplies are moving into consumption quite freely. Moderate business is reported in the United States. Consumption is on a good scale. The export quota for the second quarter of 1936 was under consideration at a meeting of the International Tin Committee in Paris yesterday (Wednesday).

Metal Exchange quotations were as follow:—

Cash.—Thursday, £208 to £208 5s.: Friday, £207 to £207 10s.; Monday, £208 15s. to £209 5s.; Tuesday, £208 to £208 5s.; Wednesday, £207 10s. to £207 15s.

Three Months.—Thursday, £201 5s. to £201 10s.; Friday, £201 5s. to £201 10s.; Monday, £201 15s. to £202 5s.; Tuesday, £200 10s. to £200 15s.; Wednesday, £200 10s. to £200 12s. 6d.

Spelter.—Values became much firmer at the beginning of the current week and touched the highest level of the year. This development was not due to any appreciative increase in the demand, but was the result of a general improvement in sentiment on all the metal markets.

Official quotations were as follow:—

Ordinary.—Thursday, £14 12s. 6d.: Friday, £14 13s. 9d.: Monday, £15 5s.; Tuesday, £15 5s.; Wednesday, £15 6s. 3d.

Lead.—The general tone of this market remains quite good. Prospects of a resumption of activity in the building trade here, with armament buying again in evidence, have caused values to rise. In the United States business remains on a good scale.

Day-to-day quotations:—

Soft Foreign (Prompt).—Thursday, £15 13s. 9d.; Friday, £15 18s. 9d.; Monday, £16 5s.; Tuesday, £16 7s. 6d.; Wednesday, £16 8s. 9d.

GANISTER

Purchase your supplies from actual Producers with over 50 years' reputation

Scientifically treated, specially ground Ganister for Cupolas, Iron & Steel Works, &c.

SPECIAL LADLE GANISTER

TRIAL BAGS FREE
Quotations on application

The ASTBURY SILICA CO.
CONGLETON, Cheshire
Est. 50 Years

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RICHARDSON'S
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AIR COMPRESSORS.

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Grams: "SANDBLAST, B'HAM."
R. J. RICHARDSON & SONS, Ltd.,
Commercial Street, Birmingham.

CROSSING THE BORDER

and the penalty

YOU see there are many good Iron Founders in the Midlands, and in the South for that matter, who have a secret yearning to mould again with a genuine Scottish Rock Sand, such as perhaps they have once been used to. They like the heavy bond, the coarse grains, the high permeability . . . Others have never known such luxuries.

The trouble comes from not being able to move large chunks of mother-earth down South from the banks and braes without the penalty of spending a lot of money—a deplorable thought!

But the merrily tapping of wayside rocks with our little geological hammers and our love of digging holes have taken effect. We've discovered nature's bounty in a natural rock moulding sand within easy reach of *the Midlands*. (EUREKA!)

It is christened Tor Rock Sand, and we baptize it with just enough water in a painstaking mill to give a wonderfully plastic, coarse, cohesive sand—a moulder's delight.

The scientific fellows say it's like this:—

CHEMICAL ANALYSIS.

Silica	86·8 %
Ferric Oxide	1·43%
Alumina	7·6 %
Lime	·22%
Magnesia	·18%
Titanic Oxide	·18%
Alkalies	1·8 %
Loss on ignition	1·6 %

MECHANICAL ANALYSIS.

Very Coarse Sand (+ 1 mm) ..	16·5%
Coarse Sand (+·5 mm − 1 mm) ..	16·0%
Medium Sand (+ ·25 mm − ·5 mm)	11·0%
Fine Sand (+ ·1 mm − ·25 mm) ..	30·0%
Silt Grade (+ ·01 mm − ·1 mm) ..	7·0%
Clay Grade (− ·01 mm)	19·5%

which doesn't explain everything, but we will if you will write to us.

GENERAL REFRACTORIES
LIMITED
Genefax House, Sheffield

Telephone: Sheffield 31113 (6 lines).
Telegrams: "Genefax, Sheffield."

LONDON OFFICE:
Russell House, Adelphi, W.C.2.
Telephone: Temple Bar 7361.
Telegrams: "Genefax, Rand-London."

SCOTTISH OFFICE:
156, St. Vincent Street, Glasgow.
Telephone: 5250.
Telegrams: "Genefax, Glasgow."

SOUTH WALES OFFICE:
11, Wind Street Swansea.
Telephone: 3680.
Telegrams: "Genefax, Swansea."

and Branch Offices, Works and Agencies throughout the world.

RAW MATERIALS—PRICE LIST

(Wednesday, February 19, 1936)

COPPER

	£	s.	d.
Standard cash	35	15	0
Three months	36	2	6
Electrolytic	40	0	0
Tough	38	10	0
Best selected	39	0	0
Sheets	68	0	0
India	49	15	0
Wire bars	40	7	6
Ingot bars	40	7	6
H.C. wire rods	44	0	0
Off. av. cash, Jan.	34	14	10⅞
Do., 3 mths., Jan.	35	2	10½
Do., Sttlmnt., Jan.	34	15	1½
Do., Electro, Jan.	39	0	3½
Do., B.S., Jan.	38	10	3½
Do., wire bars, Jan.	39	4	10½
Solid drawn tubes			10½d.
Brazed tubes			10½d.
Wire			6½d.

BRASS

Solid drawn tubes	9½d.
Brazed tubes	11½d.
Rods, drawn	8½d.
Rods, extd. or rlld.	5d.
Sheets to 10 w.g.	7¾d.
Wire	7½d.
Rolled metal	7¼d.
Yellow metal rods	5d.
Do. 4 × 4 Squares	5¾d.
Do. 4 × 3 Sheets	5¾d.

TIN

	£	s.	d.
Standard cash	207	10	0
Three months	200	10	0
English	207	10	0
Bars	208	10	0
Straits	210	0	0
Australian	207	10	0
Eastern	207	2	6
Banca	208	10	0
Off. av. cash, Jan.	209	18	9
Do., 3 mths., Jan.	201	9	0¾
Do., Sttlmt., Jan.	209	19	0

SPELTER

	£	s.	d.
Ordinary	15	6	3
Remelted	13	15	0
Hard	12	10	0
Electro 99.9	17	7	6
English	16	5	0
India	13	10	0
Zinc dust	19	10	0
Zinc ashes	4	5	0
Off. aver., Jan.	14	12	0¾
Aver. spot, Jan.	14	9	9

LEAD

	£	s.	d.
Soft foreign ppt.	16	8	9
Empire (nom.)	17	2	6
English	18	10	0
Off. average, Jan.	15	8	10⅞
Average spot, Jan.	15	7	11¼

ALUMINIUM

Ingots	£100 to £105
Wire	1/3 to 1/4 lb.
Sheet and foil	1/2 to 1/4 lb.

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	23	10	0
Do., V.M. ex-whse.	24	10	0
Rods	27	12	6

ANTIMONY

	£	s.	d.	£	s.	d.
English	72	0	0 to	73	0	0
Chinese, ex-whse.				63	0	0
Crude, c.i.f.				34	0	0

QUICKSILVER

Quicksilver	12	2	6 to	12	10	6

FERRO-ALLOYS AND STEEL-MAKING METALS

Ferro-silicon—						
25%				8	17	6
45/50%				12	15	0
75%				17	17	6
Ferro-vanadium—						
35/50%				12/8 lb. Va.		
Ferro-molybdenum—						
70/75% carbon-free				4/6 lb. Mo.		
Ferro-titanium—						
23/25% carbon-free				9d. lb.		
Ferro-phosphorus, 20/25%				£18	0	0
				to £20	0	0
Ferro-tungsten—						
80/85%				3/– lb.		
Tungsten metal powder—						
98/99%				3/3 lb.		
Ferro-chrome—						
2/4% car.				33	0	0
4/6% car.				21	15	0
6/8% car.				21	0	0
8/10% car.				21	0	0
Ferro-chrome—						
Max. 2% car.				33	10	0
Max. 1% car.				36	5	0
Max. 0.70% car.				37	5	0
70% carbon-free				9½d. lb.		
Nickel—99.5/100%				£200 to £205		
"F" nickel shot				£184	0	0
Ferro-cobalt, 98/99%				5/3 lb.		
Metallic chromium—						
96/98%				2/5 lb.		
Ferro-manganese (net)—						
76/80% loose	£10	15	0 to 11	5	0	
76/80% packed	£11	15	0 to 12	5	0	
76/80% export	(nom.)		£9	15	0	
Metallic manganese—						
94/96% carbon-free				1/3 lb.		

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 1/16 in.	1/– lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅜ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/– lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP

	£	s.	d.	£	s.	d.
South Wales—						
Heavy steel	3	5	0 to	3	7	6
Mixed iron and steel	3	0	0 to	3	2	6
Heavy cast iron	2	17	6 to	3	0	0
Good machinery	3	2	6 to	3	5	0
Cleveland—						
Heavy steel	2	17	6 to	3	0	0
Steel turnings				2	0	0
Heavy cast iron				3	2	6
Heavy machinery				3	5	0
Midlands—						
Light cast-iron scrap	2	10	0 to	2	12	6
Heavy wrought iron	3	7	6 to	3	12	6
Steel turnings				2	2	6
Scotland—						
Heavy steel				2	17	6
Ordinary cast iron	3	2	6 to	3	5	0
Engineers' turnings				2	2	6
Cast-iron borings	1	17	6 to	2	0	0
Wrot-iron piling				3	8	9
Heavy machinery	3	7	6 to	3	11	3

London—Merchants' buying prices, delivered yard.

	£	s.	d.
Copper (clean)	29	0	0
Brass	19	10	0
Lead (less usual draft)	14	10	0
Tea lead	10	10	0
Zinc	8	10	0
New aluminium cuttings	74	0	0
Braziery copper	27	0	0
Gunmetal	27	0	0
Hollow pewter	155	0	0
Shaped black pewter	120	0	0

PIG-IRON

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	72/6
,, No. 3	70/–
,, at Falkirk	70/–
,, at Glasgow	73/–
,, No. 4	69/–
Forge No. 4	69/–
Hematite No. 1	77/–
Hematite M/Nos.	76/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	77/–
,, d/d Birm.	88/6
Malleable iron d/d Birm.	115/–
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	71/–
,, No. 3 fdry.	75/–
Northants forge	68/6
,, fdry. No. 3	72/6
,, fdry. No. 1	75/6
Derbyshire forge	71/–
,, fdry. No. 3	75/–
,, fdry. No. 1	78/–
Scotland—	
Foundry, No. 1, f.o.t.	76/6
,, No. 3, f.o.t.	74/–
Hem. M/Nos. d/d	77/–
Sheffield (d/d district)—	
Derby forge	68/6
,, fdry. No. 3	72/6
Lincs forge	68/6
,, fdry. No. 3	72/6
W.C. hematite	90/–
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	78/–
Staffs fdry. No. 3	78/–
Northants fdry. No. 3	76/6
Cleveland fdry. No. 3	78/–
Dalzell, No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	83/6
Clyde, No. 3	83/6
Monkland, No. 3	83/6
Summerlee, No. 3	83/6
Eglinton, No. 3	83/6
Gartsherrie, No. 3	83/6
Shotts, No. 3	83/6

FINISHED IRON AND STEEL

Usual district deliveries for iron; delivered consumer's station for steel.

Iron—	£	s.	d.	£	s.	d.
Bars (cr.)	9	12	6 to	9	15	0
Nut and bolt iron	7	17	6 to	8	7	6
Hoops			10 10 0 and up.			
Marked bars (Staffs) f.o.t.			12	0	0	
Gas strip			10 10 0 and up.			
Bolts and nuts, ¾ in. × 4 in.			15	5	0 and up.	
Steel—						
Plates, ship, etc.	8	15	0 to	8	17	6
Boiler plts.	9	5	0 to	9	7	6
Chequer plts.			10	7	6	
Angles			8	7	6	
Tees			9	7	6	
Joists			8	15	0	
Rounds and squares, 3 in. to 5½ in.			9	7	6	
Rounds under 3 in. to ⅝ in. (Untested)			8	12	0	
Flats—8 in. wide and over			8	12	6	
,, under 8 in. and over 5 in.			8	17	6	
Rails, heavy	8	5	0 to	8	10	0
Fishplates			12	10	0	
Hoops (Staffs)			9	7	0	
Black sheets, 24g. (4-t. lots)			11	10	0	
Galv. cor. shts. (,,)			13	10	0	
Galv. flat shts. (,,)			14	0	0	
Galv. fencing wire, 8g. plain			15	10	0	
Billets, soft			5 10 0 and up.			
Billets, hard	6	17	6 to	7	2	6
Sheet bars	5	10	0 to	5	15	0
Tin bars	5	10	0 to	5	15	0

PHOSPHOR BRONZE

	Per lb. basis
Strip	10½d.
Sheet to 10 w.g.	11½d.
Wire	12½d.
Rods	11½d.
Tubes	14d.
Castings	12½d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	21.31
No. 2 foundry, Valley	19.50
No. 2 foundry, Birm.	15.50
Basic, Valley	19.00
Malleable, Valley	19.50
Grey forge, Valley	19.00
Ferro-mang. 80%, seaboard	75.00
O.-h. rails, h'y, at mill	36.37½
Billets	29.00
Sheet bars	30.00
Wire rods	40.00
	Cents.
Iron bars, Chicago	1.80
Steel bars	1.85
Tank plates	1.80
Beams, etc.	1.80
Skelp, grooved steel	1.80
Steel hoops	2.10
Sheets, black, No. 24	2.40
Sheets, galv., No. 24	3.10
Wire nails	2.40
Plain wire	2.30
Barbed wire, galv.	2.80
Tinplates, 100-lb. box	$5.25

COKE (at ovens)

Welsh foundry	26/6 to 34/-
,, furnace	20/6 to 21/6
Durham foundry	21/6 to 23/-
,, furnace	19/6 to 21/-
Scotland, foundry	30/-
,, furnace	26/-

TINPLATES

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box		18/9 to 19/-
,,	28×20	,,	37/6 to 38/-
,,	20×10	,,	27/– to 28/-
,,	18¾×14	,,	19/6
C.W.	20×14	,,	16/-
,,	28×20	,,	34/-
,,	20×10	,,	23/3
,,	18⅜×14	,,	16/3

SWEDISH CHARCOAL IRON & STEEL

Pig-iron	£6	0	0 to	£7	0	0
Bars-hammered, basis	£16	0	0 to	£16	10	0
Bars and nail-rods, rolled, basis	£15	15	0 to	£16	0	0
Blooms	£10	0	0 to	£12	0	0
Keg steel	£30	0	0 to	£31	0	0
Faggot steel	£18	0	0 to	£23	0	0
Bars and rods dead soft, st'l	£10	0	0 to	£12	0	0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

	£ s. d.	
Feb. 13 ..	35 2 6 inc.	1/3
„ 14 ..	35 10 0 „	7/6
„ 17 ..	35 17 6 „	7/6
„ 18 ..	35 16 3 dec.	1/3
„ 19 ..	35 15 0 „	1/3

Electrolytic Copper

	£ s. d.	
Feb. 13 ..	39 5 0 No	change
„ 14 ..	39 10 0 inc.	5/–
„ 17 ..	40 0 0 „	10/–
„ 18 ..	40 0 0 No	change
„ 19 ..	40 0 0 „	„

Standard Tin (cash)

	£ s. d.	
Feb. 13 ..	208 0 0 dec.	15/–
„ 14 ..	207 0 0 „	20/–
„ 17 ..	208 15 0 inc.	35/–
„ 18 ..	208 0 0 dec.	15/–
„ 19 ..	207 10 0 „	10/–

Tin (English ingots)

	£ s. d.	
Feb. 13 ..	208 0 0 dec.	25/–
„ 14 ..	207 10 0 „	10/–
„ 17 ..	209 0 0 inc.	30/–
„ 18 ..	208 0 0 dec.	20/–
„ 19 ..	207 10 0 „	10/–

Spelter (ordinary)

	£ s. d.	
Feb. 13 ..	14 12 6 No	change
„ 14 ..	14 13 9 inc.	1/3
„ 17 ..	15 5 0 „	11/3
„ 18 ..	15 5 0 No	change
„ 19 ..	15 6 3 inc.	1/3

Spelter (Electro, 99.9 per cent.)

	£ s. d.	
Feb. 13 ..	16 15 0 No	change
„ 14 ..	16 17 6 inc.	2/6
„ 17 ..	17 7 6 „	10/–
„ 18 ..	17 7 6 No	change
„ 19 ..	17 7 6 „	„

Zinc Sheets (English)

	£ s. d.	
Feb. 13 ..	22 17 6 No	change
„ 14 ..	23 0 0 inc.	2/6
„ 17 ..	23 10 0 „	10/–
„ 18 ..	23 10 0 No	change
„ 19 ..	23 10 0 „	„

Lead (English)

	£ s. d.	
Feb. 13 ..	17 15 0 inc.	5/–
„ 14 ..	18 0 0 „	5/–
„ 17 ..	18 5 0 „	5/–
„ 18 ..	18 5 0 No	change
„ 19 ..	18 10 0 inc.	5/–

Imports and Exports of Pig-Iron, Iron and Steel Castings, etc., in January, 1936, compared with January, 1934 and 1935

	January, 1934.	January, 1935.	January, 1936.	January, 1934.	January, 1935.	January, 1936.
Imports.	Tons.	Tons.	Tons.	£	£	£
Pig-iron—from British India	10,012	5,067	4,263	27,326	14,946	12,962
„ Foreign Countries	2,149	2,361	2,443	12,775	14,680	12,238
Total	12,161	7,428	6,706	40,101	29,626	25,200
Castings and forgings	158	308	566	4,224	7,847	19,266
Cast pipes and fittings	108	59	93	4,549	2,995	2,190
Stoves, grates, etc.	64	90	45	5,422	6,173	5,004
Baths	767	446	673	17,107	12,534	16,332
Hollow-ware, all kinds	271	177	303	13,773	10,508	15,977
Exports.						
Pig-iron, forge and foundry	4,886	6,347	4,128	17,469	22,066	15,900
„ acid	3,364	4,878	2,584	10,336	15,547	8,729
„ basic	545	—	28	1,747	—	112
Total	8,795	11,225	6,740	29,552	37,613	24,741
Castings and forgings	310	444	360	12,370	16,603	12,623
Cast pipes and fittings, up to 6 in. diameter	4,373	4,787	4,372	56,674	51,745	48,426
„ „ „ „ over 6 in.	3,183	3,738	4,508	26,404	26,630	42,354
Stoves, grates, etc.	747	797	887	38,599	38,338	44,884
Sanitary cisterns	298	316	246	8,366	8,520	7,789
Bedsteads, inc. tubes therefor	626	341	402	19,131	12,783	13,217
Cast hollow-ware,	317	303	409	13,043	12,020	14,435

WILLIAM JACKS & COMPANY,
WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

CLARENCE CHAMBERS, 39, CORPORATION STREET, BIRMINGHAM.
13, RUMFORD STREET, LIVERPOOL.

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All grades FOUNDRY, HEMATITE, BASIC, SPECIALS, &c.

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COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,
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ZETLAND ROAD, MIDDLESBROUGH.

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(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED

B.SC., age 25, practical experience of ferrous, metallurgy and coal distillation, 3 years' exceptional commercial experience as assistant to managing director of a commercial syndicate, including office organisation, law of contract, sales, etc., desires change. —Box 574, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

STEELFOUNDRY Foreman seeks progressive position. 37 years' practical experience in modern foundry methods; light and medium castings.—Box 560, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

TO Iron, Steel, Malleable Founders.—Gentleman (Scotsman) qualified in all branches, commercial, technical, metallurgical, desires position, control large or small foundry. To firms interested a good personal connection is at their service to increase output under efficient management. An opportunity and terms very reasonable.—Box 602, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

ASSISTANT Foundry Manager required for large repetition foundry manufacturing grey-iron castings for the motor trade, etc. Good opening for suitable man possessing technical knowledge and good organising ability. Write giving full particulars as to experience and salary required to Works Manager, QUALCAST, LIMITED, Victory Road, Derby.

MANAGER for non-ferrous foundry in Midlands producing 8 tons weekly. Must be capable of producing pressure sound work on competitive repetition basis. Give full experience.—Box 594, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

REPRESENTATIVE required for sale of refractories; ex-foundryman considered. State experience, age, and salary required.—Box 604, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

STEELFOUNDRY Foreman required, South Wales; used to light castings of high quality. State experience, age and wages.—Box 606, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

THE B.C.I.R.A. requires an Investigator for work on shrinkage and contraction. Academic qualifications desirable, but practical foundry experience a recommendation. State age, education, experience, and salary required, to DIRECTOR, 21-23, St. Paul's Square, Birmingham, 3.

BUSINESS FOR SALE

IRON FOUNDRY IN NORTH MIDLANDS for private disposal, now working to capacity, over 100 tons per month; perfect satisfaction guaranteed; fullest investigation offered. Retirement sole reason.—Address Box 598, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

AGENCIES

AGENTS required, London area, also North-East Coast, for sale of Core Compounds and Foundry Requisites. Practical experience of the foundry trade essential.—Box 596, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

WANTED.—Agents with connection amongst foundries, London, Birmingham, Manchester, Glasgow and districts, to represent Sheffield firm making foundry specialties. Good commission.—Box 600, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

MACHINERY

FOR SALE.—Second-hand Moulding Machine by Adaptable, Birmingham. Squeeze-type No. 11. Capacity 20 in. by 23 in.—Apply UNIVERSAL ENGINEERING CO., Nottingham.

42-IN. Buckley & Taylor gear-wheel Moulding Machine for disposal, in excellent condition. Price £40.—ALEX. HAMMOND, 14, Australia Road, Slough.

FOR SALE AT LOW PRICES TO AVOID REMOVAL.

TILGHMAN Sand-blast Room Plant, complete with sand-blast apparatus, Sturtevant exhaust fan, air trunking, and dust-collecting box. Size of room 18 ft. by 9 ft. by 8 ft.

Tilghman ditto, but with room 12 ft. by 12 ft. by 8 ft. high.

Air Compressors could be supplied to each.

At present lying at works Wolverhampton.

Sclerascope for hardness-testing of metals.

S. C. BILSBY, A.M.I.C.E., A.M.I.E.E., CROSSWELLS ROAD (Adjoining Railway Crossing), LANGLEY, Nr. Birmingham. 'Phone: Broadwell 1359.

FOR SALE.—Three "Ajax" No. 9 Turnover Moulding Machines and one "Ajax" Stripping-Plate Moulding Machine with vibrator, complete with all accessories. Can be seen under working conditions. Price £50 each. —THOMAS BROADBENT & SONS, LIMITED, Huddersfield.

Tilghman Sandblast Barrel Plants; barrel sizes—60 in. x 40 in.; 36 in. x 20 in.; 20 in. x 30 in.

Tilghman Sandblast Cabinet Plants; 4 ft. 6 in. and 3 ft. 6 in. square (one for high pressure 70 lbs. per sq. in.); also small Cabinet 30 in. dia.

All complete with Air Compressors, etc.

Pneulec Royer Sand Thrower, size No. 1.

Six Osborne Pneumatic Jolt Press Moulding Machines, size 75J.

Three Mumford Yoke Headpress Pneumatic Moulding Machines.

Two Herbert Whizzer Sand Disintegrators.

Two Brealey Type ditto.

Heavy Double-ended Grinding Machines by Rowlands, Luke & Spencer, etc.

Hand Moulding Machines by Adaptable Darling & Sellars, Pridmore, Samuelson, etc.

500 Electric Motors, Dynamos, Rotary Converters, etc.

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THOS. W. WARD LTD.

Rope Pulley-drive RUMBLING MACHINE; 30" dia. wheels; barrel 16" dia. x 15" long; mounted on two bearings.

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'Grams: "Forward." 'Phone: 23001 (10 lines).

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NEW Dwarf Cupola, to melt 10 to 15 cwts. per hr. New Worm-geared Ladles, 5 tons, 25 cwts., 15 cwts. and 10 cwts. capacity. Ungeared Ladles, 15 cwts. and 10 cwts. capacity. Improved Cupola Spark Arresters.—T. DAVIES & SON, West Gorton, Manchester.

'Phone: 287 SLOUGH

MOULDING MACHINES

Three jolt roll-over Britannia Machines, as new. Cheap.
Eight No. 1 Britannia Jolters. Price **£26 each.**
Modern Tabor Squeeze Roll-over Machine. Price **£75.**
Osborn Hand Roll-over Machine. Price **£28.**
Six Denbigh Hand Jolters, various sizes.

CUPOLAS

4' 6" dia. shell Davies Cupola, with A.C. Fan. NEW.
30" dia. Cupola in new condition, complete. **£38.**
30" dia. New Cupolette complete with fan, **£30.**

TILTING FURNACES—Oil and Coke Fired.

AIR COMPRESSORS—All sizes.

PLEASE SEND US YOUR ENQUIRIES.

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BUY FROM ME AND SAVE MONEY!

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